Lachs 1, 2

CHEMICAL & METALLURGICAL ENGINEERING

CHEMICAL & MET. ENGINEER

Co., Inc. July 27, 1921 25c. per copy

The modern "man at the fire"

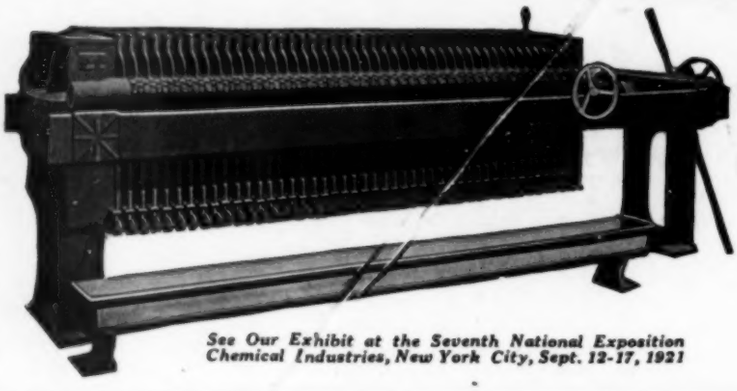
Have you ever noticed the uniform quality of product put out by those plants that have found, by experience, that

ENGELHARD PYROMETERS

are good Pyrometers to standardize on.

CHARLES ENGELHARD, Inc.
30 CHURCH STREET, NEW YORK CITY

See our Exhibit at the Seventh
National Exposition Chemical Industries
New York City, September 12-17, 1921



See Our Exhibit at the Seventh National Exposition Chemical Industries, New York City, Sept. 12-17, 1921

Shriver Efficiency

Many years of producing filter presses for all types of filtration work enable us to guarantee the results.

This guarantee of efficiency goes with every filter press we sell—we know our product, and we are ready to stand back of it. Write for catalog stating your filtration problem.

T. SHRIVER & CO.
808 Hamilton Street, Harrison, N. J.

Improved Coal Dryers

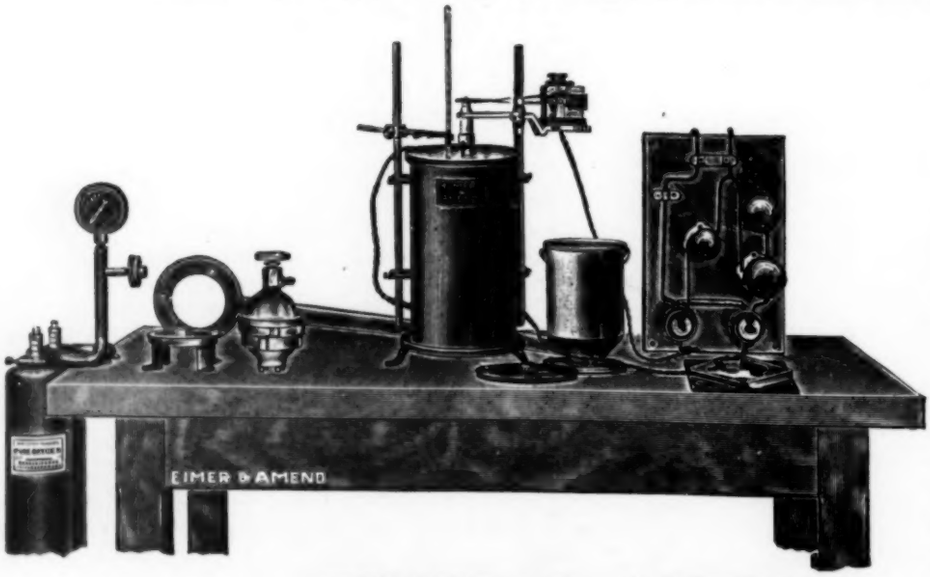
The first Ruggles-Coles Dryer on coal was introduced over twenty-three years ago. Each year has seen added improvements to insure greater efficiency, longer life, more accessibilty and superior drying effects.

Today, the Ruggles-Coles Dryer is the recognized standard for users of pulverized coal.

Ruggles-Coles Engineering Company
120 Broadway New York City

Standard Bomb Calorimeters

Emerson and Parr, Regular and Adiabatic



The Emerson has the bomb lined with Nickel, Monel metal, Gold or Platinum. The Parr has the bomb lined with the acid resisting Illium metal.

Write for Calorimeter section of our new catalog and state your requirements.

EIMER & AMEND

New York City:
Third Ave., 18th to 19th St.

Established 1851.

Pittsburgh Office:
4048 Jenkins Arcade

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

H. C. PARMELEE, Editor
ELLWOOD HENDRICK, Consulting Editor
ERNEST E. THUM, Associate Editor
SIDNEY D. KIRKPATRICK, Assistant Editor

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT, Assistant Editors
CHESTER H. JONES, Industrial Editor
J. S. NEGRU, Managing Editor

Volume 25 — New York, July 27, 1921 — Number 4

A Serious Economic Problem

EUROPE is now offering to help the United States obtain the sum due under reparation arrangements for actual destruction of American property by Germany. The effort appears to be to assist the United States in getting about three-fourths of a billion dollars due its citizens in order that the United States will in turn assist Europe in collecting the 70 billion payable to the Allies under the treaty. Despite its apparent selfishness, the attitude appears to be diplomatic and fair to the United States. However, underlying all this there is an economic problem of vital significance to chemical as well as other industries.

Already the effort of Germany to meet its financial obligations has resulted in a curtailment of its luxury imports which is proving to be almost fatal to the French wine industries. One famous international statesman has also ascribed the British coal-mine strike directly to the reparation requirement that Germany supply given tonnages of coal to France, Italy, Belgium and others. If so early in the plan two large industrial disasters are caused by compliance with treaty obligations, what can we expect when Germany is well under way in the effort to meet the total obligation of 70 billion dollars?

That this question is of industrial importance, as well as of banking or credit significance, at once appears when we realize that the payment must be made in goods. It cannot be made in money or credit of any sort whatsoever.

Germany recognizes one economic principle and may undertake to apply it in the chemical industries to American disadvantage. This principle is that only a small percentage surplus above the market demand often, if not invariably, results in a large decrease in market prices. What would happen, for example, in the American chemical industry if Germany would see to it that there were always available in the United States markets about 10 to 15 per cent more of a particular chemical than the market was currently able to absorb?

That Germany may be quite capable of this, both industrially and morally, is well recognized.

Presumably the liquidation of credits and the restoration of buying power in the United States will proceed surely, even though slowly, to better times. It is well known that agriculture, representing perhaps one-fourth of the population, and labor out of work, representing with its dependents 10 or 15 per cent more, cannot buy much beyond the bare necessities right now. But times will improve even without the artificial stimulant of legislation, subsidy or governmental co-operation. We can expect something like normal relationships.

On the other hand, we can be sure that Germany cannot last indefinitely on a basis which provides from the Government a subsidy for industry to the extent of a billion and a half dollars per year gold (figuring the mark at five or six cents). To continue that scheme indefinitely would be lifting oneself by one's own economic boot straps, a thing which does not work in economic affairs any better than in physics. When the subsidy is eliminated, the relationship between Germany and the rest of the world will be more favorable than now to the rest of the world.

In the meantime the main essential for America is recognition of the need for better technology in all processes, closer industrial co-operation all the way from resource to user, and plain hard work.

The Bottom of The Chemical Market

IN DANGEROUS channels the wise skipper takes many soundings. To steer a safe course down the harbor, he must occasionally have an answer to the important question, How near the bottom are we? So, too, the course of the buyer or seller in the chemical market is influenced by similar considerations. He wants to know: How near the bottom are our chemical prices? How do chemicals stand in relation to the products of other industries? Has the process of deflation been completed?

Fortunately, some "soundings" recently made by the Department of Commerce may be of help in answering these perplexing questions. The price indexes, compiled in connection with the monthly studies of industrial movements, show the relative changes in the wholesale prices of chemicals and drugs during 1920 and the first five months of 1921 and afford a valuable means of comparing these articles with other commodities of commerce.

Using the average for 1913 as a base of 100, the relative index for the wholesale prices of chemicals during the first three months of 1920 was 197, for the second three months 215, for the third 218, and for the fourth 204. The maximum for the year was reached in September, and since that time there has been a gradual and continuous falling off, until for May, 1921, an index of 166 is reported. This means, in other words, that during that month the particular chemicals and drugs studied were selling for two-thirds more than in 1913.

How then do chemicals compare with other commodities? The price indexes during the same month of May, 1921, were 117 for farm products, 133 for food, 138 for metals, 181 for clothing, 194 for fuel, 202 for building materials, 263 for housefurnishings, and the average for all was 151. Thus it would appear that the prices of chemicals have fallen somewhat less than those of metals or food products, but are nevertheless at a level comparable with the average for all commodities. Building materials, house furnishings, clothing and fuel, all of which directly affect the consuming public,

remain at higher levels and apparently have not yet taken their proportionate share in the general process of deflation.

These price indexes do not give us an answer to all our inquiries, but they are soundings which should not be disregarded as we are approaching the bottom of chemical prices.

Metallurgical Literature

IN RESPONDING to the Fritz Medal Award, Sir ROBERT HADFIELD made a brief address of thanks, which was supplemented by the distribution of printed pamphlets, appropriate to his desire to convey his high appreciation of the honor. In this pamphlet, after a brief account of his discoveries in alloy steels, for which the medal was given, and the influence of such special steels on the advancement of science, Sir ROBERT passes on to a consideration of the history and works of the Royal Society since its incorporation 260 years ago. He also remarks that the quality and amount of literature in a particular branch of science generally show the relative position it occupies in the world.

This is well illustrated in the science of metallurgy. Starting with AGRICOLA there is with a few exceptions little contained in the books of the chief writers of metallurgy up to 1880 which is of present value, even though the list comprises such authors as DUD DUDLEY (1665), REAUMUR (1722), SWEDENBORG (1734), RINMAN (1782), BERTHOLET (1789), BERZELIUS (1833), DAVID MUSHET (1840), FARADAY (1842), PERCY (1861), HOLLEY (1865), WHITWORTH (1866), GRUNER (1872), and LEDEBUR (1877). Aside from building a sure foundation of chemical analysis, and producing PERCY'S admirable treatises on practice, the preceding years had merely constructed a body of empirical rules-of-thumb, discovered by the method of trial and error. Too often such a discovery was hid within an iron-works and closely guarded as a trade secret, until it was found that everyone else had discovered the same thing.

The decade 1875-1885 witnessed the renaissance of metallurgy. That marvellous series of mechanical appliances which have revolutionized blast furnace practice, steel making and fabricating were devised and put into use. The invention of manganese steels opened a vista of possibilities in alloying which will never become exhausted. Men turned to the physicist and borrowed his microscopes and electrical indicators, and leaned more heavily upon the familiar chemist. But best of all, the profession profited immeasurably by a long list of notable contributions to the *Transactions* of the British Iron and Steel Institute, and the American Institute of Mining Engineers. Indeed, the literature as represented by texts on General Metallurgy and on its specialized branches, has not yet had a chance to overcome the long lead established by periodical literature, represented by society transactions and the technical press. Practice is advancing by such leaps and bounds that "book knowledge" may be permanently outdistanced.

Tens of thousands of metallurgists throughout the world are devoting their attention to scientific and practical metallurgy, and smaller societies now abound. And all this has come about in but 50 years! One wonders what would have been the situation without a vigorous and prolific literature, available to the student young or old, who is intent upon widening his knowledge and skill.

Time to Change Doctors

DR. POLITICS prescribed an old remedy for a new ailment and a great many people are becoming skeptical of its efficacy. The tariff in the old days was the Republican panacea for all industrial ills but with the changed industrial conditions surrounding our present international situation, it is beginning to be apparent that the time has arrived to change doctors. We regard it as a sign of the times, therefore, that the Senate may be asked to pigeon-hole the tariff bill just passed by the House, and we hope that it will not be revived until the public can make certain that there is not a better and more constructive way to meet the situation.

Tariff revision has been under way for almost a year, and while there has been a gradual and growing opposition, most of us have been content to wait in hopes that somehow and in some way the Ways and Means Committee would report out some wonderful measure that would accomplish the miraculous. The failure of the emergency bill to relieve the plight of the farmers caused many to lose faith in the tariff. And finally the Fordney bill with its radical rates and objectionable features and the high-handed manner in which it was forced through the House, have aroused a nation-wide storm of protest and disgust.

The failure of the dye bill is of most concern to the chemical industry even though our views may differ as to the need for tariff revision at this time. CHEMICAL & METALLURGICAL ENGINEERING has always taken the stand that a complete and well-balanced dye industry is essential to this or any other country concerned with its national defense. Whether or not an embargo is necessary to accomplish this, we can not say, but we do believe that the industry warrants more than usual consideration. If this is to be received from the Senate, the industry must see that many false charges are answered and many unfavorable impressions corrected.

Princeton In the Saddle

AND now comes Princeton with its school of engineering, four years for a bachelor's degree and one year more for that of engineer. The course is to include a good grounding in physics, chemistry, mathematics, languages, literature, philosophy, economics and sociology. The young man is to achieve, if teaching can give to him, a broad outlook on everyday problems; and the endeavor, according to the announcement made in the July 15 number of *Science*, will be to make an engineer rather than a specialist. Professor ARTHUR M. GREENE, JR., of the Rensselaer Polytechnic Institute is to be dean of the new school and professor of mechanical engineering. He will take up his duties in the fall of 1922.

It's curious, and there's a touch of comedy in it withal, that a considerable group of self-styled humanists, like cherubim and seraphim continually do cry over these developments. That engineering, or the use of science, should enter into higher education as one of its constituent features seems to them the end of intellectual joy. What they fail to recogize is their own modernness in presenting their views. They are shining examples of the defects of modern education for the reason that they are narrow specialists. They weep like children for more and more dead languages and they lack the art to make them alive.

Let us analyze the situation in regard to Greek and Latin, the teaching of which has been going on for a very long time and over which there is the most continuous rumpus. We start as boys, learning declensions and conjugations in Latin and after a year of memorizing we begin with CAESAR'S Commentaries. From the standpoint of human history these looting expeditions are not of prime importance, but the study is not even pursued as history; it is followed as an almost (to the boy) interminable series of exercises in Latin Grammar. Then comes VIRGIL, about 20 lines a day, again with no thought of the legends, the history, the poetry or anything else but the letter without the spirit of the thing. About this time the boy starts with Greek, and XENOPHON'S interesting history is used solely for parsing lessons; and then comes HOMER with the same story better told in Greek than VIRGIL told it in Latin, and this again is seldom much more than a series of parsing lessons. So we go on as boys with parsing lessons in Latin and Greek for about twelve years—and at the end of that time we do not know either the language or its literature.

If we were to teach science that way, without any purpose beyond "the mental exercise" of so much memorizing—there wouldn't be any science. But if the Latin class were to study Latin as a living thing and then even in secondary schools address itself to rendering into English excerpts from the great store of mediaeval records, the boys themselves would get a sense of research, of discovery, of the service of learning—and they would have a working understanding of the language. We can recall the day when the learned clergyman who could converse in Greek was a distinguished scholar. That day is past. Nearly every peanut vendor on the street can converse in Greek. Not very elegant Greek perhaps—but it is Greek. By less worry about the irregularities of verbs and more study of the classic Greek drama as literature and as great cartoons of life, students would acquire the very qualities of mind, would grasp the relations of cause to effect and effect to cause, would sense the inviolability of Nature's laws, and know the fundamental truths which underlie human intercourse that men of science most urgently need.

We urge upon the moaning company of pseudo-classicists the merit of drying their tears. Princeton has not fallen from grace. Engineering has become a part of the life of today. It is not a substitute for history or philosophy or the study of mankind. Engineering alone does not give a man a liberal education—nor does a knowledge of Greek give culture to the peanut wallah. The greatest effort of present day, earnest men of science is toward making their successors persons of large understanding and culture, and above all things to help them develop into men of character so that they may fashion their careers unto righteousness. But more and more the fact is being brought out that engineering is needed in daily life. We need it if we intend to do things and most sound boys, thank GOD, want to do things. We need it also in archaeology and in the study of human history. It is the index of civilization.

The Greeks, by the way, were excellent engineers and the Romans copied from them. In the days of the renaissance—well, there was LEONARDO DA VINCI. After a letter of several pages in which he told in detail to the Pope many of the things he could do, including almost every branch of engineering then known, he concluded with the sentence, "I can also paint."

Fluctuations and Drifts in Prices

WE HAVE all seen by experience that commodity prices fluctuate. They did that even before the war showed us how violently they could move upon sufficient provocation. There has been question, however, as to the general drift, that is, the general tendency when a smooth curve is drawn through the graph plotted from recorded prices.

The statistician of the Russell Sage Foundation, Dr. RALPH G. HURLIN, has carried back to 1810 an index number of commodity prices and back to 1820 the average wage rate of common labor and a composite wage rate of five classes of artisans—carpenters, house painters, machinists, blacksmiths and compositors. This information is definite and useful. The graph of wholesale commodity prices, from 1810 to 1920, is hardly what one would expect. The striking thing is not a general trend or drift. The impressive thing is three immense peaks, of approximately equal height, one for our war of 1812, or rather our little branch of the Napoleonic wars, a second for the Civil War and a third for the year 1920. After 1815 and 1865 prices showed a generally recessive trend for approximately 30 years in each case. The general drift is a trifle difficult to pick out. The trough between 1890 and 1900 is considerably lower than the trough between 1840 and 1850, but on the other hand there is but a slight ascent in the 15 years or so before the Civil War while there is rather a sharp ascent between 1896 and 1914. Certainly the last war did not forecast its shadow in that manner.

However, one man's composite or budget is not another man's. Timber would certainly show a general sweep upwards in the past century while watches, up to the time of the watch that made the dollar famous, would show an equally impressive downward trend. The proper generalization probably is that on account of the increasing volume of media of exchange, the trend of values is upward over long periods while improvements in the art of producing many things exerts an influence in the opposite direction, and the two may balance or be slightly out of balance according to the selection of articles that go to make up one's weighted average of "commodities in general."

Dr. HURLIN'S wage showing, on the other hand, admits of no argument. The trend was almost continuously upward from 1820 to 1910, the chief irregularity being a bulge at the time of the Civil War, most of which came off in the industrial depression of 1873-8. Wages approximately tripled from 1820 to 1910. The recent war bulge makes almost a vertical line in the graph and of course that peak is going to come off. A very interesting feature of the showing is that the artisans' average ran quite uniformly at about 80 per cent above the common labor rate, and approximately that percentage is likely to be restored.

Counting out the influence of wars, then, there does not seem to be any very marked drift in commodity values, measured by gold, over long periods of time. Wages and salaries have a strong drift upward, which means that relative to the earnings of the individual, commodity prices trend downward, as a result of improvements in methods and appliances. But the greatest thing of immediate concern is that in two conspicuous cases, one 56 years ago and the other more than a century ago, it took fully 30 years for prices to recede completely from their peak. We had a precisely similar peak in 1920.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, June 30, 1921.

SOME recovery in foreign exchange took place during June that averted a further reduction in many prices, despite the continuance of the crisis in all industries and the consequent financial difficulties. These caused the chemical industrials at a meeting held in Milan to cancel last November's agreement with their employees to give three months' notice in case of dismissals. The representatives of the labor organizations objected and it was agreed to give the months of July, August and September as notice to the workpeople and to discuss new agreements in October. The shortage of English coal continued, which was in many cases made up by American, Belgian and French coal. The shortage had little effect, owing to the exceedingly low demand for combustibles on the part of industry in general and to the reduced maritime traffic.

ITALIAN MATCH INDUSTRY

The Italian match industry during June went through a very severe crisis, caused by the Italian government failing to draw several large lots of matches and by the fact that the government abolished the monopoly existing during the war too late to prevent other nations invading the foreign markets which Italy formerly supplied. The Italian phosphorus match industry dates from 1831, when wood matches were manufactured for the first time in a works established at Empoli. In 1894 the industry was subjected to a special tax that brought an income of 7,000,000 lire to the Italian government.

ITALIAN QUININE MANUFACTURE

The extraction of quinine and the working of quinine salts was tried in Italy, but till the war the infant industry was suffocated by German competition which by selling under cost killed Italian endeavor in this direction. The government has now undertaken the production of quinine and of its different salts in a works of its own and is also trying to get plantations of cinchona in other countries so as not to be obliged to depend for its raw materials on foreign markets. Quinine and its salts are of great importance to Italy and its colonies where these products are largely employed in combating malarial fevers.

PROHIBITION ON IMPORTATION OF DYESTUFFS

A law has been promulgated prohibiting the importation of dyestuffs from any source whatever. This law gives the Minister of Finances power to grant individual importation permits for products which cannot be produced in Italy or which cannot be produced in sufficient quantity.

DEVELOPMENTS IN HYDRO-ELECTRIC PLANTS IN THE SILA PLAINS

There is much activity in all parts of Italy for increasing the electric energy obtained through water power. Work is being conducted with great intensity on the high Sila plains, where construction has been begun on a large dike which will make possible the utilization of a large artificial lake formed by abundant waterfalls. It is expected that this will supply energy for the electrification of all the railways and industries in southern Italy. Powerful auto lorries are used to convey the construction materials from Cotrone, Catanzaro and Cosenza.

A NEW HYDRO-ELECTRIC COMPANY

A recent decree authorized the formation at Unide of a new firm of great importance for the whole region north of the Veneto. This firm, bearing the name of Forze Idrauliche del Friuli, is authorized by the government to utilize all the hydraulic forces of the River Tagliamento, its effluents, and of any other river in the region. The company will undertake the construction of electric plants and provide electric energy for them. No limit is placed on its capital, and some of the most important banks will finance it.

ITALIAN FERTILIZER NECESSITIES

Owing to the ground having suffered impoverishment in phosphorus during the war, when the peasant neglected his fields, reducing or discontinuing entirely the treatment of them with fertilizers, a campaign has been started for an extensive use of superphosphates during the next season. It is pointed out that the consumption of phosphorus, which was 1,000,000 tons annually before 1914, fell to 500,000 tons during the war, rising to only 600,000 tons in 1918 and 650,000 tons in 1920. The limited yield of the Italian works during the first months of this year left no stocks on hand, but arrivals of superphosphates were very fair, reaching 56,485 tons in March and 47,697 tons in April.

ITALIAN SULPHUR INDUSTRY

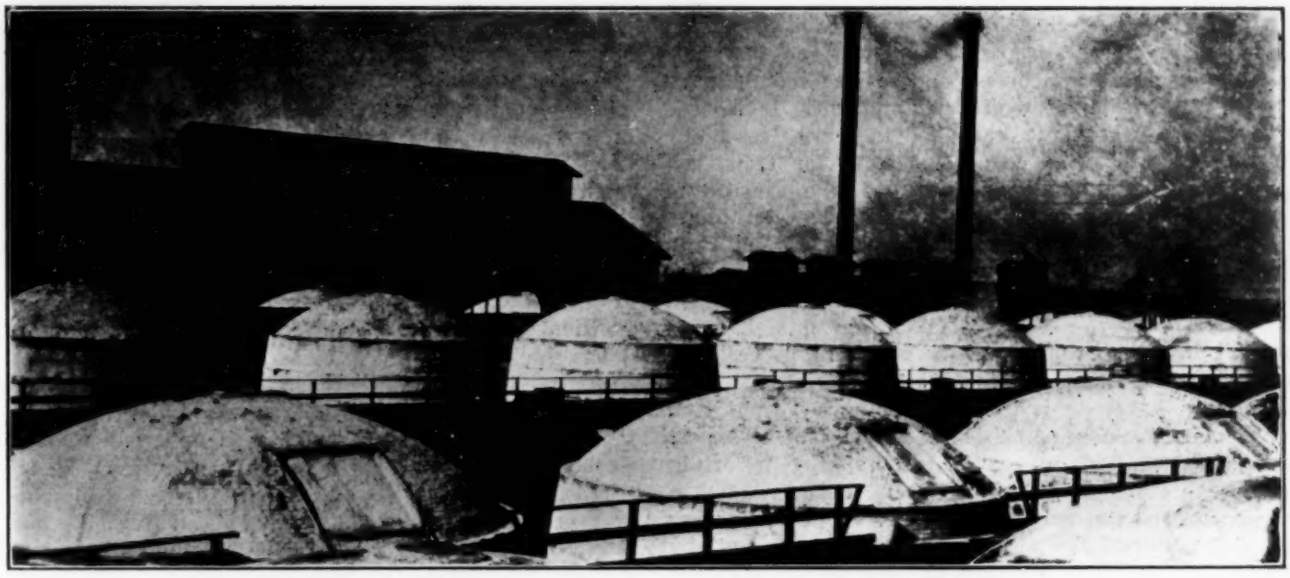
The Italian sulphur industry suffered during June in consequence of the wave of reduction that affected all other industries. The sales of the nine months ended in April last reached only 140,000 tons, against 206,000 tons during the twelve months preceding. Up to nearly the beginning of this century Sicily had a world monopoly as regards sulphur. However, after the discovery of the Louisiana sulphur mines the situation changed completely, and a great deal of business was lost through the competition of these mines, which had the advantage of being more modernly worked, while in Sicily little change had been introduced and old-fashioned methods of extraction were used. At present Italian sulphur is competing with difficulty against the American product not only in the American market but also in Europe. Through the initiative of the proprietors of Sicilian sulphur mines a new firm has been founded at Palermo having a capital of 3,000,000 lire, and sulphur refineries close to the sites of extraction will be built.

Italian Imports and Exports During 1920

The values of imports and exports for 1920 by great groups of commodities are given in the following table:

	Imports — Millions, Lire —			Exports — Millions, Lire —		
Group	1913	1919	1920	1913	1919	1920
Raw materials	1,387	5,302	5,014	360	758	989
Semi-manufactured materials	705	2,842	3,249	591	2,153	2,269
Manufactured articles	851	2,616	3,365	798	2,191	3,292
Foodstuffs and live animals	703	5,864	4,233	762	963	1,253
Total	3,646	16,624	15,861	2,511	6,065	7,803

In the matter of exports more or less notable gains have been made to all countries, with the exception of France and Tripoli, the largest increases being to the Argentine Republic, Switzerland, the United States, Brazil, Egypt, British India, and Spain, in the order named.



BRICK KILNS ARRANGED FOR BYPRODUCT RECOVERY

Hardwood-Distillation Industry—I

Importance of Hardwood-Distillation Products in Industrial Life—Periods in the History of This Industry —Commercial Methods of Distillation—Relation Between the Composition of Wood and Its Distillation Products

By L. F. HAWLEY*

THE United States is by far the greatest producer and consumer of wood-distillation products. The only other countries which have an output large enough to make a showing in a table of statistics are Austria, Germany and Canada. The following table gives the estimated annual production of the four countries for the period just previous to 1914:

	Acetate, Tons	Methanol, Gal.	Wood, Cords
United States	80,000	9,000,000	1,000,000
Germany and Austria[1]	25,000	2,800,000	300,000
Canada	8,500	950,000	110,000

Aside from these countries, England, Sweden, France, Japan and Italy are known to have small wood-distillation industries. During the war great efforts were made in England to develop this industry, and several small plants were built; but the combined output of these plants would not be greater than that of one medium-sized plant in this country. In 1917 the output of methanol and acetate of lime in Sweden was about equal to the output of a single plant with a capacity of 50 cords of hardwood per day. Sweden has several well-built wood-distillation plants, and the explanation of the small output is that hardwoods are not abundant and resinous wood is the raw material commonly used, resulting in a low production of methanol and acetic acid. In 1915 Japan had developed an industry which gave an output equivalent to about one 50-cord plant. France has had a small industry of this kind for some time, and Italy has been doing some preliminary work along this line. A very small industry started in Argentina, and shipments of wood-distillation apparatus to India from this country have been recently reported. Government officials and representatives of private companies have been sent to this country from Australia to investigate wood-distillation for the purpose of establishing plants in that country, but no construction has been started as yet.

The large capacity of the wood-distillation industry in the United States is probably due to the great supply of good-quality hardwoods available for this purpose, as well as to the increasing demand for the products.

The immense supplies of hardwood in the tropics have not been touched yet for the purpose of wood-distillation and we have no information in regard to their suitability.

Importance of Hardwood-Distillation Products in Industrial Life

Charcoal.—Charcoal has been known and used as a fuel since prehistoric times, but at present it has only special fuel uses. Probably the largest single use of this kind is in blast furnaces for the manufacture of charcoal iron. Many wood-distillation plants are built in connection with blast furnaces, and their entire output of charcoal is used for this purpose. It is also used largely as a special domestic fuel, and considerable quantities are still employed in the manufacture of black powder. Charcoal has also a large number of miscellaneous uses, such as in stock and poultry foods, in case-hardening compounds, and as a deodorizer and insulator.

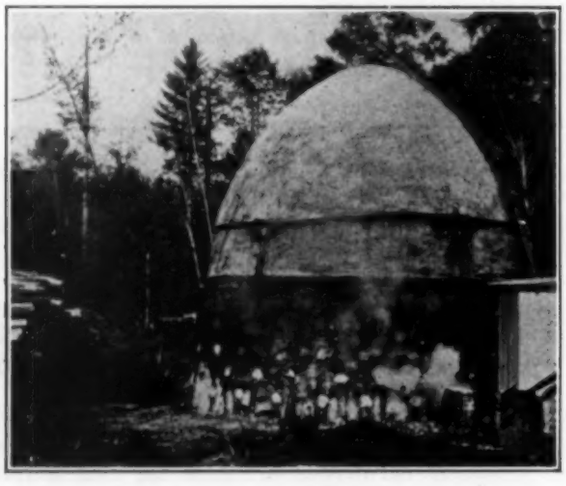
*In charge Section of Derived Products, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

[1] The United States Tariff Commission report dated 1921 shows that about 1,800,000 gal. of methanol was exported for Austria-Hungary in 1913. Most of the crude products were manufactured in what is now Czecho-Slovakia.

Acetic Acid.—Acetic acid has a wide use in the chemical industry in the preparation of various inorganic acetates such as lead, copper, and sodium acetates, and in the preparation of white-lead pigment. It is used widely in the organic chemical industry, especially in the preparation of cellulose acetate for films, lacquers, plastics and artificial silk; and in the preparation of various organic acetates, such as methyl, ethyl and amyl acetates which are used as solvents. In enters in the manufacture of various synthetic organic chemicals, even though the acetyl group may not appear in the final product. It has also several miscellaneous uses, such as in textile plants in the dyeing process and on rubber plantations for coagulating the latex.

Acetone.—Acetone is used largely as a solvent, and for certain purposes of this kind it seems to be almost indispensable. This is especially the case with certain cellulose acetate films and lacquers, which require a large proportion of acetone in the solvent for obtaining the best results. The standard high-explosive used by the British—cordite—requires the use of acetone as a solvent in its manufacture. Large quantities of acetone have also been used as a solvent for acetylene in portable lighting and welding outfits.

Methanol.—Methanol has a large number of uses for which there seems to be no substitute possible. Formerly the largest use of methanol in this country was as a solvent in the manufacture of varnishes and lacquers,



BEEHIVE CHARCOAL KILN WITHOUT BYPRODUCT RECOVERY

especially those containing shellac. This use has, however, declined very rapidly of late, and only small quantities of methanol are now being used for this purpose. The uses in which methanol enters into chemical reaction with other materials have been rapidly growing.

A recently developed use of methanol as a solvent is in connection with the manufacture of moving-picture films. Its main chemical use is probably in the manufacture of formaldehyde, as it is the only raw material from which formaldehyde has been produced commercially. Formaldehyde is a standard disinfectant for general use in hospitals and sick-rooms. An even more important use for formaldehyde, however, is found in the eradication of various fungus diseases which attack seed grains. The Department of Agriculture has recommended the use of formaldehyde treatment for potatoes and for many grains, in order to prevent these diseases and increase the yields of the products. Formaldehyde is also the base used in the rapidly increasing production of synthetic resins, such as Bakelite and Redmanol. Methanol is now used in the preparation of certain dyes which require the presence of the methyl group. Methyl acetate and methyl salicylate, or artificial oil of wintergreen, and other similar methyl esters require methanol in their production.

Methyl Acetone.—Methyl acetone, which is a mixture of methanol, acetone, methyl acetate and other impurities in small quantities, is obtained during the refining of methanol. This material naturally varies in composition as produced at different refining plants, but it has the same general uses in all cases—namely, as a solvent. It has solvent properties very similar to acetone and in general superior to those of pure methanol. Its special use, however, is in the denaturing of ethyl alcohol.

Wood Tar.—Wood tar has not yet become an important product of wood distillation, although there has been considerable development along this line within the last few years. Flotation oils, solvent oils, heavy tar oils for paints, stains, preservatives and insulating pitch are some of the important products obtained from wood tar. One important product for which wood tar is the only raw material is the medicinal beechwood creosote which has been manufactured to a considerable extent in this country since 1915.

Periods in the History of the Hardwood Distillation Industry

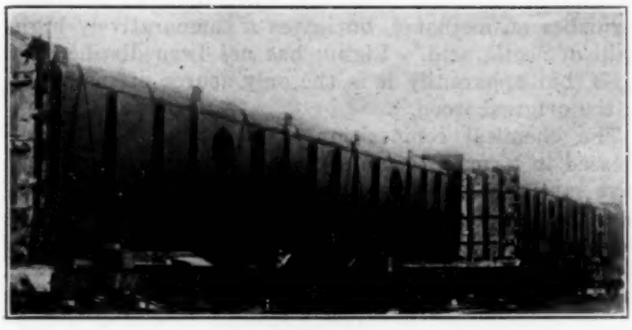
There are several periods which stand out distinctly in the development of the hardwood distillation industry, as determined by the change in the demand for certain products. For a long time the industry was given an indirect subsidy by the Government in the form of a tax placed on ethyl alcohol for industrial purposes. This made it possible for methanol to be used and sold at a price much higher than the cost of manufacture of ethyl alcohol. It was during this period that the great use of methanol as a solvent was developed in the manufacture of spirit varnishes, in the hat-making industry and in many other places where its solvent action made it a good substitute for ethyl alcohol.

In 1906 the denatured-alcohol legislation was passed making it possible to use ethyl alcohol for industrial purposes without paying the excise tax. This put methanol in direct competition with ethyl alcohol in cases where solvent action only was required, and the market price of the product immediately dropped to about the same level as that of grain alcohol. Conditions in the hardwood distillation industry were very unfavorable for some time; but slightly increased prices for charcoal and acetate of lime helped the situation, and there continued to be a fair demand for methanol, although at a very reduced price. This condition continued until about 1915, when the demand for acetate of lime began to increase rapidly, owing to the fact that one of the main explosives used by the British Government required acetone in the process of manufacture. After the reserve stocks on hand were used up the price of acetate of lime increased very rapidly, and for some time was held at $7 a hundredweight, when the maximum price previous to the war had been $2.50. This demand for acetate was much greater after the entrance of this country into the war, since both acetone and acetic acid were important constituents of the airplane-wing "dope" required in large quantities by our airplane program. Methanol did not have such

important war uses, and its price was not greatly affected. Both of these products, however, were commandeered by the Government, and the selling price was fixed. After the Government restrictions were removed the price of methanol increased, while that of acetate of lime decreased.

The change in price for acetate of lime was due to two causes. One of these was the large stocks which had been stored during the war and the other was the competition which had been developed through new processes developed during the war for the manufacture of acetic acid and acetone.

The increase in the price of methanol was due to the rapidly increasing use of this material in chemical



WOOD-DISTILLATION RETORTS

manufacture. Our newly established dye industry required considerable quantities of methanol, and the various other chemical uses for this product had increased greatly. The recent decrease in demand is difficult to explain, except by general business conditions.

Methyl acetone obtained in the refining of methanol has also shown great changes in demand. At the time it was first produced it had practically no value, because its solvent properties were not well known and both the odor and color of the product were unpleasant, but it gradually developed that this material had very unusual solvent properties, and as the color and odor were improved it was used more and more. Since the denatured alcohol bill went into effect in 1907 there has also been a slowly increasing demand for this material as a denaturant. Charcoal has also had many ups and downs following the demand for charcoal iron to a great extent, but these have not occurred in well-defined periods like the other products.

Commercial Methods of Wood-Distillation—Retorts, Kilns and Ovens

The distillation of wood has long been an industry in the form of the manufacture of charcoal without the recovery of any byproducts. This was accomplished by kilns in which the heat required for the distillation of wood was furnished by a partial combustion of the wood and its distillation products by means of a regulated draft of air through the kiln.

In this country there were two paths by which the charcoal industry progressed toward the modern wood-distillation industry in which the chemical byproducts are the chief products. One of these was the brick byproduct kiln, in which the same method of heating was continued, but the draft was regulated artificially and the products of combustion and distillation were carried through condensers and recovered. The yield of chemicals from the byproduct kilns was only about one-half of that which can be obtained by the distillation of the wood in closed vessels with heat applied from the outside. Nevertheless the byproduct kilns continued in use, particularly in northern Wisconsin and Michigan, where large quantities of charcoal were required for use in charcoal-iron furnaces. Several such plants are still in operation, but no new ones have been built recently and some of them have already been remodeled into modern oven plants.

The other path by which the wood-distillation process advanced from the kiln process to the modern methods was by way of the retort process. These retorts were cylindrical, horizontal, and about 5 ft. in diameter by 9 ft. in length. They were commonly set in furnaces with one firebox for two retorts. The wood was loaded into the retort by hand, and the hot charcoal was raked out also by hand labor. In the eastern part of the wood-distillation district these retort plants were very common, and they became the standard distillation apparatus for a time.

The modern oven for wood-distillation is at present the standard type of distillation apparatus, and all of the new plants recently built have been of this type. The ovens were developed with the main purpose of decreasing the amount of labor required, and they were very successful in this direction, since the wood was run into the ovens on cars and the charcoal removed from the retorts on the same cars without requiring any handling. From this point of view the ovens are very efficient, and the yields obtained per cord of wood are also as great as have been obtained in the other commercial forms of distilling apparatus. The ovens are about 6 ft. by 8 ft. in cross-section, and the wood on the cars does not touch the sides of the oven at any point.

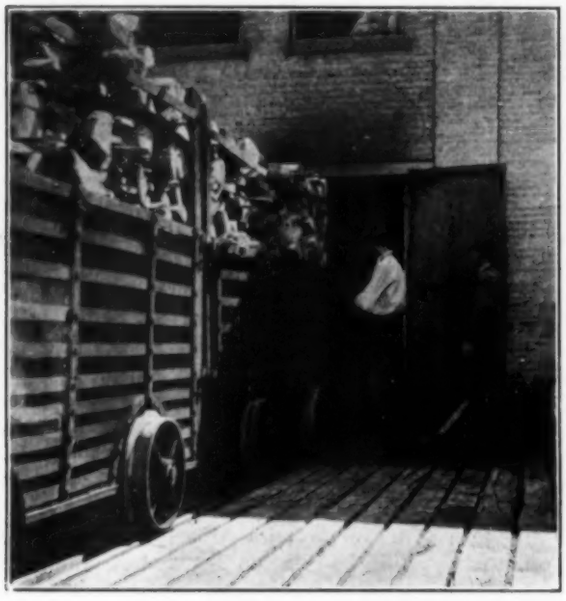
The great disadvantage in the use of such ovens is that in order to bring the center of the charge up to the

LOADING BUGGIES WITH WOOD

required temperature it is necessary that the retort surface be heated to a considerably higher temperature than necessary for the distillation of the wood, which results in high depreciation on the ovens in cases where extreme care is not taken in the control of the fire.

Artificial Drying of the Wood

The wood is commonly air-dried from twelve to eighteen months previous to distillation. This is necessary on account of the fact that green wood not only requires more fuel and a longer time to distill but the



WOOD GOING INTO DISTILLATION OVENS

liquors are also increased in amount by the moisture in the wood, with the result that during the refining process larger capacity apparatus and more fuel would be required.

There is considerable disagreement in regard to the effect of moisture in the wood in the yields of methanol and acetic acid; but it is generally considered that, even if moisture does increase the yields, it is not enough to make up for the increased costs of distillation and refining.

The cost of air-drying is considerable, since the interest on the value of eighteen months' wood supply is a large item of expense, and the handling of the wood in piling it for drying and in loading on the cars after drying is also expensive.

Within the last three or four years methods for artificially drying distillation wood have been worked out, and the same general method with modifications is in use at three plants. The woodyard for drying purposes is replaced by what are called pre-driers. These consist of brick or tile buildings, holding from one to three days' supply of wood on cars, in which the wood is heated and dried by direct contact with the flue gases from the retort stacks. The flue gases are taken from the stacks by means of fans and distributed along the hot end of the pre-drier, usually by flues underneath the cars. Some trouble was encountered at first with sparks carrying over from the flues and igniting the wood on the cars; but by using baffles for stopping the sparks and by determining the maximum safe temperature at which the gases could enter the driers this difficulty has been avoided.

As the drying of wood takes place very much more rapidly through the ends of a stick than in the direction at right angles to the grain, it was naturally found that the wood could be dried more rapidly and completely when cut into blocks instead of being left in the usual 4-ft. lengths of cordwood. At two plants the wood is cut into blocks and the blocks are loaded into cars from hoppers without being touched after sawing. At one plant the wood is still being dried in 4-ft. lengths, although the drying is then not so complete.

Short blocks of wood dumped into a car by gravity feed from a hopper will give more weight of wood in a car than can be loaded into the same car by hand in the form of 4-ft. cordwood.

The labor required for handling the wood in the storage yards and the interest on the investment, insurance, taxes, etc., on stored wood are expenses which are entirely eliminated by the use of pre-driers. It also makes the plant more independent of weather conditions and it is possible for a new plant to start without the necessity of collecting a wood supply eighteen months before the plant is ready for operation.

Relation Between the Composition of Wood and Its Distillation Products

The two main constituents of wood—namely, cellulose and lignin—are very different in their yields of wood-distillation products. Cellulose when distilled by itself furnishes no methanol, but gives a comparatively high yield of acetic acid.[2] Lignin has not been distilled by itself, but apparently it is the only source of methanol in the original wood.

The chemical composition of wood is usually expressed in terms of certain groups of substances which have special solubilities or give certain reactions. For instance, "methoxy group," "acetic acid by hydrolysis," "alkali soluble," "water soluble" and "ether soluble" are common terms used in reporting a wood analysis.

The methoxy group is the one of most interest in wood distillation. Its determination is not a direct measure of the amounts of methanol which can be obtained by destructive distillation of the wood; but, in general, the woods which give the higher methoxy determinations give also the largest yield of methanol. The ratio between the percentage of methoxy group and percentage of methanol obtained by distillation is approximately 3 to 1, and this indicates the possibility of obtaining considerably higher yields of methanol from wood by some method of modifying the source of the distillation.

The acetic acid content as obtained by hydrolysis varies considerably with different species, but does not seem to have a direct relation to the amount of acetic acid obtained by destructive distillation. The acid obtained by hydrolysis is also less than the amount obtained by distillation and therefore does not indicate a possibility of larger yields of acid. It is possible, however, to decompose wood in such a manner as to obtain larger yields of acetic acid than have ever been obtained by destructive distillation. Thus a treatment with a large proportion of caustic soda at a temperature of about 200 deg. C. may yield as high as 15 per cent of acetic acid.[3] Apparently, therefore, there is nothing in the composition of wood substances which makes it impossible to obtain considerably increased yields of both methanol and acid by some modification of the process of distilling.

The other constituents of wood, such as "water soluble," "ether soluble," etc., are not of much importance in connection with wood-distillation, since these constituents occur usually only in small amounts. In cases where the resins occur in large quantity these become important by themselves; and, as in the case of "lightwood" from longleaf pine, they form the basis of a special distillation industry.

Parts II and III will be published in subsequent issues.

---

[2]Klason, von Heidenstam and Norlin, "Arkiv för Kemi, Mineralogi och Geologi, 1907," *Z. Angew. Chem.* vol. 25, p. 1205 (1909).

[3]Mahood and Cable, *J. Ind. Eng. Chem.*, 1919.

Comparison of the Fusing Temperature of Coal and Coke Ash

BY HAROLD J. ROSE

A knowledge of the fusing temperature of ash has proved to be of considerable value in comparing the clinkering tendencies of various fuels. Although a large amount of reliable information has been published on the fusing temperature of ash of United States coals, very little information is available regarding the fusing temperature of coke ashes.

A series of tests has been made to determine whether it is permissible to assume that the fusing temperature of a coke ash is identical with that of the ash of the coal from which the coke was made. The following results have been obtained. All determinations were made according to the American Society for Testing Materials 1920 "Tentative Method for Determination of Fusibility of Coal Ash.":

The permissible difference allowed in duplicate determinations by the A.S.T.M. 1920 Tentative Method is as follows: Same analyst, 54 deg. F.; different analyst, 90 deg. F.

It is evident from the results obtained that the fusing point of coal ash is not affected by the coking process, and that either coal ash or coke ash may be used for determining the fusing temperature of ash of the coal in question.

Description of Sample			Per Cent Ash in Coal	Per Cent Sulphur in Coal	Fusing Temp. of Ash		Coal Ash F. T. Minus Coke Ash F. T.
State	County	Seam			Coal Deg. F.	Coke Deg. F.	Deg. F.
Penna.	Fayette	Pittsburgh	9.11	1.28	2,507	2,480	27
Penna.	Fayette	Pittsburgh	7.73	1.03	2,399	2,448	—49
Penna.	Westmoreland	Pittsburgh	13.59	1.85	2,354	2,354	0
W. Virginia	Marion	Pittsburgh	9.28	1.97	2,120	2,102	18
W. Virginia	Harrison	Kittanning	11.72	1.84	2,282	2,273	9
Kentucky	Pulaski	No. 4	9.86	1.05	2,354	2,399	—45
Kentucky	Harlan	Harlan	5.34	0.84	2,520	2,475	45
Kentucky	Harlan	Harlan	6.25	0.86	2,581	2,563	18
Illinois	Franklin	No. 6	8.44	1.13	2,245	2,273	—28
Nova Scotia	Cape Breton		2.98	1.50	2,075	2,057	18
80% Penna.	Westmoreland	Pittsburgh	11.48	1.00	2,595	2,595	0
20% Penna.	Somerset	U. Kittanning					
80% Penna.	Westmoreland	Pittsburgh	....	....	2,615	2,615	0
20% Penna.	Somerset	U. Kittanning					
Average			....	....	2,387	2,386	+1

The Koppers Co. Laboratories,
Mellon Institute,
Pittsburgh, Pa.

Physical Tests on Sheet Nickel Silver*

Nickel Silvers Both High and Low in Nickel Were Studied — Cold-Worked High Nickel Is Softer and Works Better and Requires a Higher Temperature for Recrystallization, After Which It Has Higher Strength and Less Elongation Without Damaging Its Cold-Working Properties

BY WILLIAM B. PRICE AND PHILIP DAVIDSON†

WE PRESENT a survey of some of the physical properties of sheet nickel silver, when subjected to cold rolling and when annealed at a variety of temperatures extending from 350 deg. C. throughout the commercial annealing range.

PREPARATION OF SPECIMENS

A number of alloys were taken from stock and analyzed. Four of these, representing low-nickel and high-nickel both with and without lead were chosen for the tests. The analyses follow:

Alloy	Per Cent Cu	Per Cent Pb	Per Cent Fe	Per Cent Ni	Per Cent Mn	Per Cent Zn
A	64.68	Trace	0.194	6.73	0.06	Remainder
B	65.82	1.27	0.227	6.17	0.06	Remainder
C	65.44	Trace	0.345	17.83	0.08	Remainder
D	65.60	1.08	0.238	17.77	0.06	Remainder

These alloys were then rolled in accordance with the regular mill practice to approximately No. 6 B. & S. gage. At this stage all of the bars (which were then coiled) were annealed together in a mill muffle. After the annealing treatment, the bars were pickled in a 10 per cent sulphuric acid solution and cold-rolled in stages of approximately one number (B. & S.) at a time. After each stage suitable samples were set aside for physical tests. Additional samples were also chosen for tests after prescribed annealing treatment. The method of sampling is indicated below:

ROLLED SERIES	ANNEALED SERIES
No. 6, annealed in Mill	
Rolled to No. 6½ B. & S. Gage	
Rolled to No. 7	
Rolled to No. 8 (sampled)	Samples were taken at the indicated stages and annealed together in the mill muffle. After pickling, they were finished on 0.050-in. gage yielding a series of specimens 2, 4, 6 and 8 numbers hard for the subsequent annealing tests.
Rolled to No. 9	
Rolled to No. 10 (sampled)	
Rolled to No. 11	
Rolled to No. 12 (sampled)	
Rolled to No. 13	
Rolled to No. 14 (sampled)	
Rolled to No. 15	
Rolled to No. 16	
Rolled to No. 17	
Rolled to No. 18	

Tensile test-pieces 9 x 1 in. were cut from both lots and the central portion was milled to give a test section 2½ in. long by ½ in. wide. A distance of 2 in. was marked off on the edge of each specimen with light punch marks. Erichsen test-pieces 4 x 2½ in. were

*Presented in part before the 1920 Columbus meeting of the Institute of Metals Section, American Institute of Mining and Metallurgical Engineers.

†Chief chemist and metallurgist, and metallurgist, respectively, Scovill Manufacturing Co., Waterbury, Conn.

also taken from the annealed alloys, along with the tensile specimens.

Methods of Testing

Brinell tests were made with an Olsen hydraulic machine as preliminary tests on the tensile test-pieces, using pressure of 500 kg. for 30 seconds with a 10-mm. ball. The tensile tests were made on a 50,000-lb. Olsen testing machine adjusted to take a maximum load of 5,000 lb. The yield point was considered as that load necessary to produce a permanent set of 0.001 in. in 2 in. and was obtained by measuring the elongation of the specimen during the test with a pair of dividers.

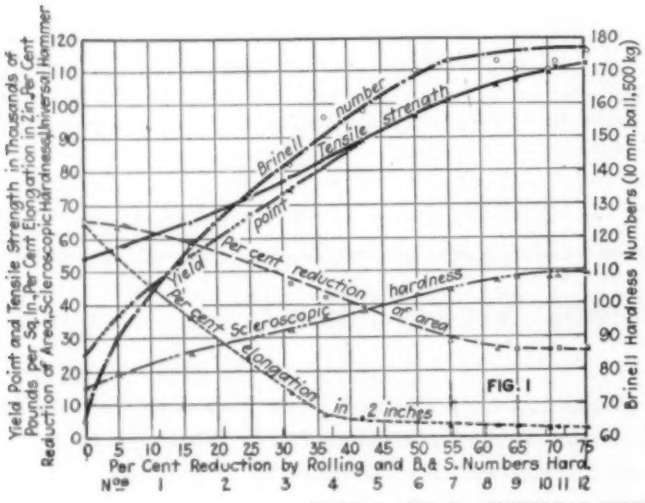
Scleroscopic hardness tests were also made on the

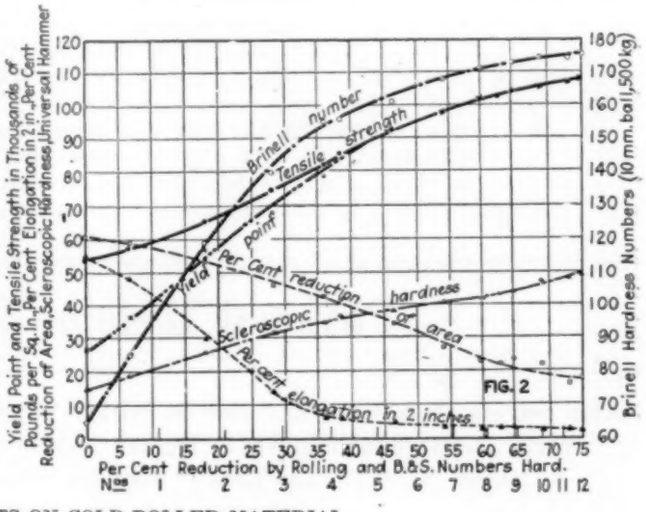
TABLE I. PHYSICAL TESTS ON THE COLD-ROLLED MATERIAL
Alloy A.—Analysis: Copper, 64.68 per cent; lead, trace; iron, 0.194 per cent; nickel, 6.73 per cent; manganese, 0.06 per cent; zinc, remainder.

Gage	Per Cent Red. by Rolling	Yd. Pt., Lb. per Sq.In.	Ten. Str. Lb. per Sq.In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard.	Brin. No.
0.1545	Mill anneal	24,666	53,767	64.5	65.7	15	65
0.1465	5.17	37,233	57,467	54.7	63.0	19	90
0.1295	16.18	54,933	64,533	35.8	59.5	25	118
0.1165	24.59	67,400	71,400	23.7	53.1	30	132
0.1065	31.06	74,000	77,800	13.3	46.3	32	142
0.0985	36.24	80,733	83,267	6.8	42.3	36	156
0.090	41.74	84,550	88,733	5.8	39.1	38	158
0.0775	49.83	96,367	96,367	4.7	34.1	43	170
0.0645	58.25	101,500	101,500	3.5	28.5	44	173
0.0585	62.13	105,533	105,533	3.2	26.2	47	173
0.054	65.04	106,867	106,867	3.2	26.2	48	170
0.0465	69.9	109,733	109,733	2.5	26.3	48	170
0.0445	71.19	110,967	110,967	2.8	26.6	48.5	174
0.038	75.41	112,300	112,300	2.5	26.5	49	176

TABLE II. PHYSICAL TESTS ON THE COLD-ROLLED MATERIAL
Alloy B.—Analysis: Copper, 65.82 per cent; lead, 1.27 per cent; iron, 0.227 per cent; nickel, 6.17 per cent; manganese, 0.06 per cent; zinc, remainder.

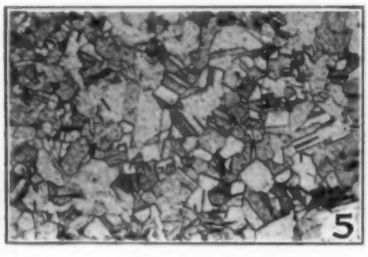
Gage	Per Cent Red. by Rolling	Yd. Pt. Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard.	Brin. No.
0.1555	Mill anneal	26,633	53,700	55.2	61.2	15	65
0.1455	6.44	36,300	57,333	48.3	59.1	19	85
0.1275	18.0	57,033	65,367	30.7	53.6	26.3	119
0.1115	28.29	67,667	74,200	14.2	45.9	32	140
0.0995	36.01	78,633	82,167	6.7	42.5	35	155
0.095	38.90	82,800	85,067	6.2	41.9	37	156
0.0835	46.30	92,033	92,033	5.0	34.7	38.5	161
0.0715	54.02	97,833	97,833	3.5	27.0	41	168
0.0625	59.80	101,467	101,467	3.3	23.0	42	171
0.0585	62.37	102,267	102,267	3.3	22.2	43.5	171
0.0555	64.38	103,900	103,900	3.3	23.7	44	173
0.0485	68.81	105,267	105,267	2.2	22.1	47.5	174
0.0425	72.66	106,533	106,533	2.5	16.7	48.5	174
0.0395	74.53	107,767	107,767	2.2	18.0	49	175

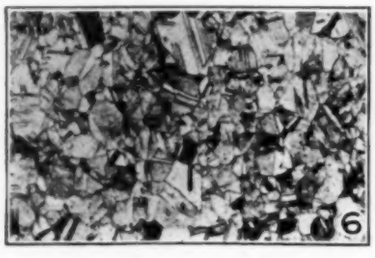

Yield Point and Tensile Strength in Thousands of Pounds per Sq.In., Per Cent Elongation in 2 in., Per Cent Reduction of Area, Scleroscopic Hardness, Universal Hammer
Brinell Hardness Numbers (10 mm. ball, 500 kg.)
Brinell number
Tensile strength
Yield point
Per cent reduction of area
Per cent Scleroscopic hardness
Per cent elongation in 2 inches
FIG. 1
Per Cent Reduction by Rolling and B.&S. Numbers Hard.
Nos 1 2 3 4 5 6 7 8 9 10 11 12

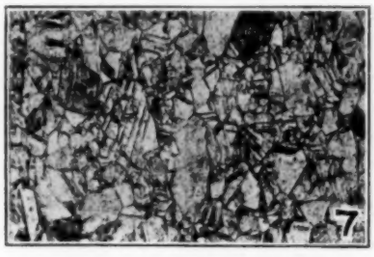

Yield Point and Tensile Strength in Thousands of Pounds per Sq.In., Per Cent Elongation in 2 in., Per Cent Reduction of Area, Scleroscopic Hardness, Universal Hammer
Brinell Hardness Numbers (10 mm. ball, 500 kg.)
Brinell number
Tensile strength
Yield point
Per Cent reduction of area
Scleroscopic hardness
Per cent elongation in 2 inches
FIG. 2
Per Cent Reduction by Rolling and B.&S. Numbers Hard.
Nos 1 2 3 4 5 6 7 8 9 10 11 12

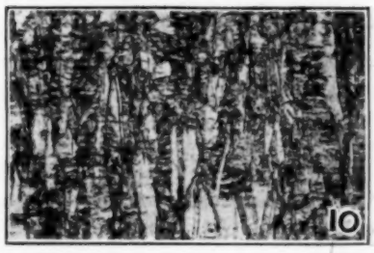
FIGS. 1 AND 2. PHYSICAL TESTS ON COLD-ROLLED MATERIAL

Fig. 1—Alloy A. Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder.
Fig. 2—Alloy B. Analysis: Copper, 65.82%; lead, 1.27%; iron, 0.227%; nickel, 6.17%; manganese, 0.06%; zinc, remainder.









FIGS. 5 TO 10. MICROSTRUCTURE OF ROLLED SERIES, ALLOY A

Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder. Etched with $NH_4OH + H_2O_2$. × 75. Fig. 5—Mill anneal. Fig. 6—16.18% reduction. Fig. 7—31.06% reduction. Fig. 8—41.74% reduction. Fig. 9—62.13% reduction. Fig. 10—75.41% reduction.

tensile test-pieces, using the Shore universal hammer. Erichsen ductility tests were carried out with a special machine equipped with standard Erichsen tools, but so designed that the pressure required to produce a cup was measured on the Olsen testing machine. The advantages of such a machine over the standard Erichsen machine are that the speed of cupping can be made very uniform, the end point is very sharp, and finally the load necessary to cup the material can be measured with precision.

TABLE III. PHYSICAL TESTS ON THE COLD-ROLLED MATERIAL

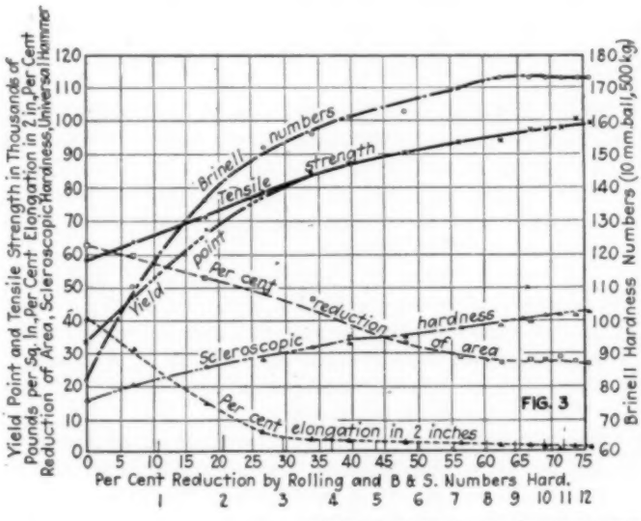
Alloy C.—Analysis: Copper, 65.44 per cent.; lead, trace; iron, 0.345 per cent; nickel, 17.83 per cent; manganese, 0.08 per cent; zinc, remainder.

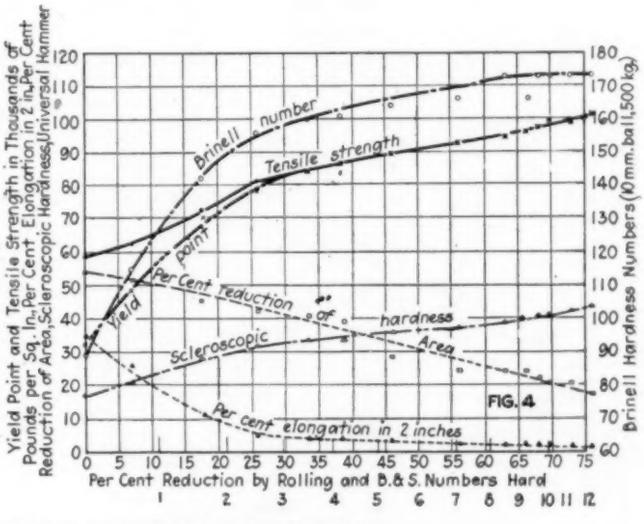
Gage	Per Cent Red. by Rolling	Yd. Pt. Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard.	Brin. No.
0.1605	Mill anneal	33,033	58,133	40.2	62.5	15.8	82
0.149	7.16	46,900	63,100	31.2	59.6	20.3	110
0.132	17.75	66,267	70,800	14.7	52.8	26.0	136
0.1175	26.79	76,733	78,333	6.5	48.7	28.0	152
0.106	33.95	81,300	84,067	4.3	46.7	32.0	156
0.097	39.56	86,367	86,367	3.7	34.9	33.0	161
0.0835	47.97	90,133	90,133	3.2	33.3	35.0	163
0.070	56.38	93,633	93,633	3.2	29.4	38.0	170
0.0605	62.30	94,133	94,133	2.7	27.6	39.0	173
0.0535	66.66	97,333	97,333	2.5	28.3	40.0	173
0.0495	69.15	97,500	97,500	2.2	28.2	42.0	173
0.046	71.53	97,900	97,900	1.5	29.1	42.0	173
0.0425	73.52	100,500	100,500	2.3	27.7	42	173
0.0385	76.01	99,767	99,767	2.0	27.2	43	173

TABLE IV. PHYSICAL TESTS ON COLD-ROLLED MATERIAL

Alloy D—Analysis: Copper, 65.60 per cent; lead, 1.08 per cent; iron, 0.238 per cent; nickel, 17.77 per cent; manganese, 0.06 per cent; zinc, remainder.

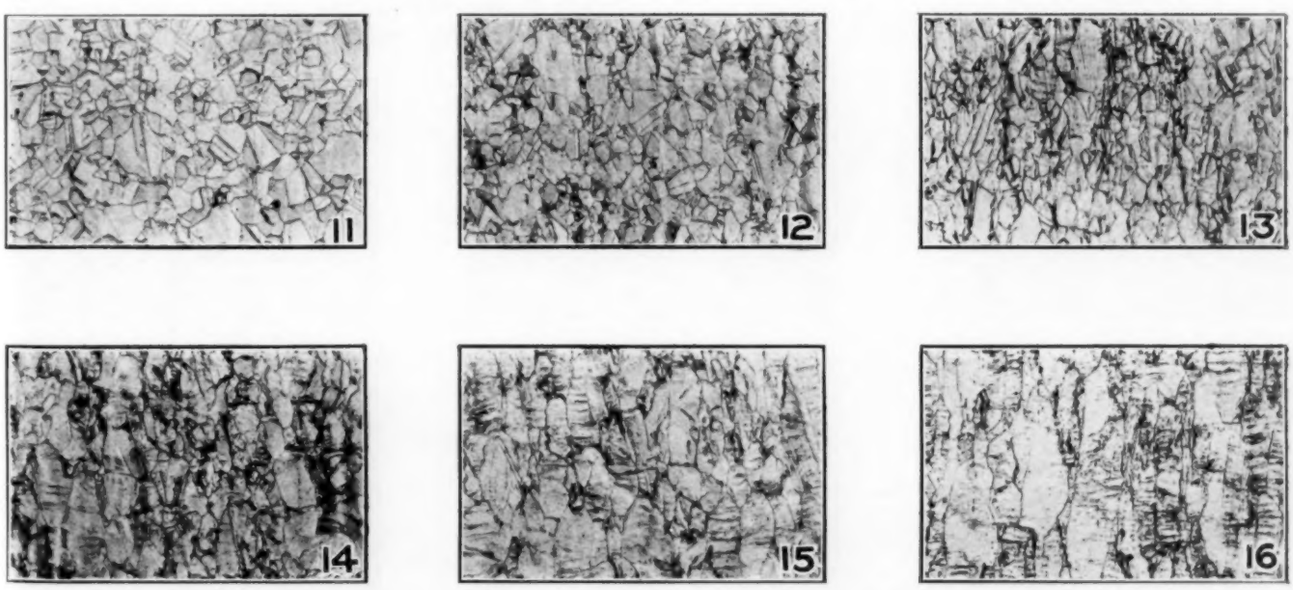
Gage	Per Cent Red. by Rolling	Yd. Pt. Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard.	Brin. No.
0.1585	Mill anneal	32,367	59,133	35.0	54.2	17	89
0.1475	6.94	48,900	62,600	26.0	51.9	21	115
0.1305	17.66	70,500	72,600	11.3	45.5	28	142
0.1175	25.86	78,750	81,067	5.0	42.2	32	156
0.1055	33.43	83,767	83,767	4.2	40.8	33.5	160
0.0975	38.48	86,567	86,567	4.0	39.5	33.8	161
0.0855	46.05	89,433	89,433	3.5	28.3	36	164
0.0695	56.15	92,733	92,733	2.8	24.0	37.5	166
0.0585	63.09	94,467	94,467	2.5	24.2	39	173
0.0535	66.24	95,933	95,933	2.5	23.8	40.5	166
0.0505	68.13	97,400	97,400	2.2	22.3	41.2	173
0.048	69.71	99,767	99,767	2.3	20.7	41.5	173
0.0425	73.18	99,100	99,100	1.8	20.6	42.5	173
0.038	76.02	101,733	101,733	1.5	17.0	43.7	173


Yield Point and Tensile Strength in Thousands of Pounds per Sq. In., Per Cent Elongation in 2 in., Per Cent Reduction of Area, Scleroscopic Hardness, Universal Hammer
Brinell Hardness Numbers (10 mm. ball, 500 kg.)
Brinell numbers
Tensile strength
Yield point
Per cent reduction of area
Scleroscopic hardness
Per cent elongation in 2 inches
Per Cent Reduction by Rolling and B & S. Numbers Hard.
FIG. 3


Yield Point and Tensile Strength in Thousands of Pounds per Sq. In., Per Cent Elongation in 2 in., Per Cent Reduction of Area, Scleroscopic Hardness, Universal Hammer
Brinell Hardness Numbers (10 mm. ball, 500 kg.)
Brinell number
Tensile strength
Yield point
Per Cent reduction of Area
Scleroscopic hardness
Per cent elongation in 2 inches
Per Cent Reduction by Rolling and B. & S. Numbers Hard
FIG. 4

FIGS. 3 AND 4. PHYSICAL TESTS ON COLD-ROLLED MATERIAL

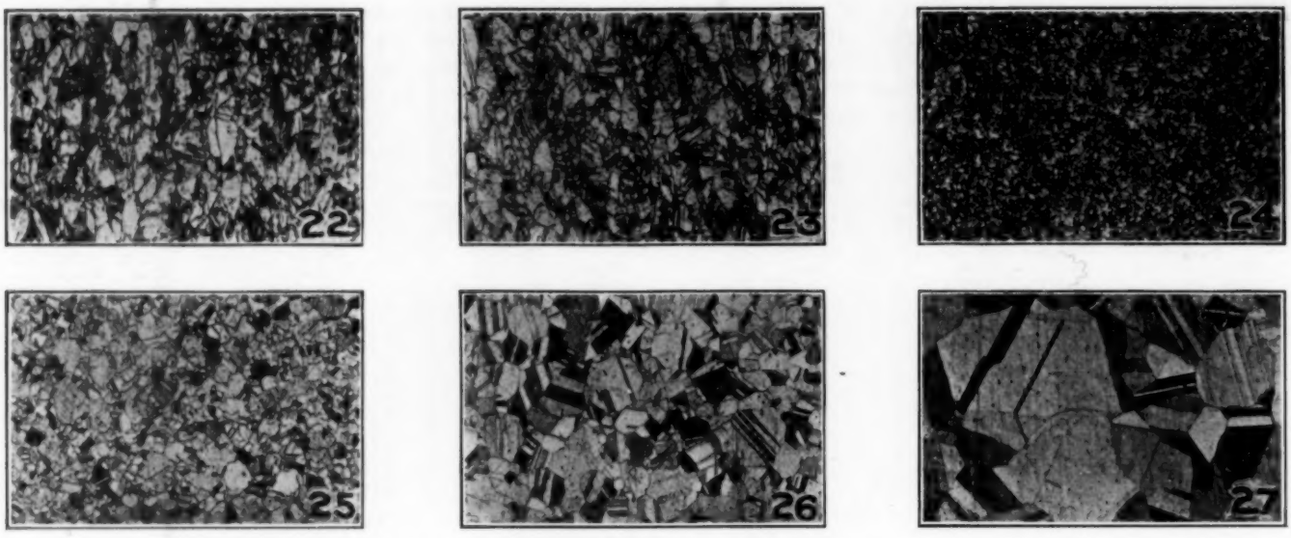
Fig. 3—Alloy C. Analysis: Copper, 65.44%; lead, trace; iron, 0.345%; nickel, 17.83%; manganese, 0.08%; zinc, remainder.
Fig. 4—Alloy D. Analysis: Copper, 65.60%; lead, 1.08%; iron, 0.238%; nickel, 17.77%; manganese, 0.06%; zinc, remainder.



FIGS. 11 TO 16. MICROSTRUCTURE OF ROLLED STEEL SERIES, ALLOY C

Analysis: Copper, 65.44%; lead, trace; iron, 0.345%; nickel, 17.83%; manganese, 0.08%; zinc, remainder. Etched with $FeCl_3$. × 75.

Fig. 11—Mill anneal. Fig. 12—17.75% reduction. Fig. 13—33.95% reduction. Fig. 14—47.97% reduction. Fig. 15—66.66% reduction. Fig. 16—76.0% reduction.



FIGS. 22 TO 27. MICROSTRUCTURE OF ANNEALED SERIES, ALLOY A

Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder. Etched with $NH_4OH + H_2O_2$. × 75.

Fig. 22—51.9% reduction. Fig. 23—Annealed at 350 deg. C. Fig. 24—Annealed at 425 deg. C. Fig. 25—Annealed at 575 deg. C. Fig. 26—Annealed at 650 deg. C. Fig. 27—Annealed at 835 deg. C.

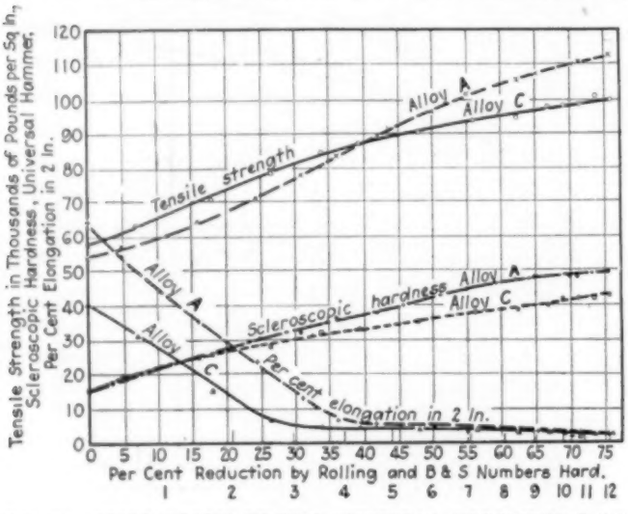
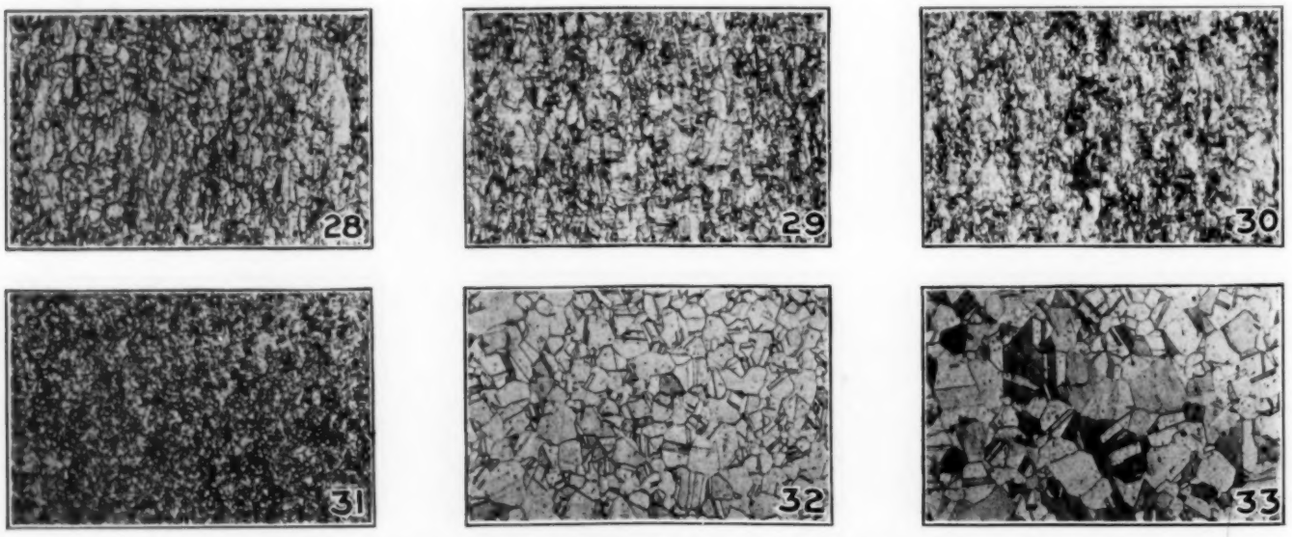

Tensile Strength in Thousands of Pounds per Sq. In., Scleroscopic Hardness, Universal Hammer, Per Cent Elongation in 2 In.
Tensile strength
Alloy A
Alloy C
Alloy A
Alloy C
Scleroscopic hardness
Alloy A
Alloy C
Per cent elongation in 2 In.
Per Cent Reduction by Rolling and B & S Numbers Hard.

FIG. 17. COMPARISON OF THE PHYSICAL PROPERTIES OF COLD-ROLLED ALLOYS A AND C

Specimens for microstructure were also taken from the ends of the test specimens before pulling. Alloys *A* and *B* were etched with $NH_4OH + H_2O_2$, while dilute acidified ferric chloride solution was used in the case of alloys *C* and *D*. All micrographs were made at a magnification of 75 diameters.

The results of the physical tests made on the rolled specimens are shown in Tables I, II, III and IV, each item representing the average of three determinations. They are represented graphically in Figs. 1, 2, 3 and 4. Representative micrographs of alloys *A* and *C* are shown in Figs. 5 to 16 inclusive.

The significance of these results may be best appreciated by an examination of the accompanying curves, Figs. 1, 2, 3 and 4. In a general way the nickel silvers with the lower nickel content are slightly harder than brass subjected to similar treatment. The nickel silvers with the higher nickel content, however, although slightly harder when in the annealed condition, do not harden as rapidly under severe cold-rolling as those



FIGS. 28 TO 33. MICROSTRUCTURE OF ANNEALED SERIES, ALLOY C

Analysis: Copper, 65.44%; lead, trace; iron, 0.345%; nickel, 17.83%; manganese, 0.08%; zinc, remainder. Etched with $FeCl_3$. × 75.

Fig. 28—52.7% reduction. Fig. 29—Annealed at 429 deg. C. Fig. 30—Annealed at 500 deg. C. Fig. 31—Annealed at 575 deg. C. Fig. 32—Annealed at 750 deg. C. Fig. 33—Annealed at 835 deg. C.

with the lower nickel content. The comparison is shown graphically in Fig. 17. In works practice, as a matter of fact, alloys with the higher nickel content are considered more amenable to cold-working operation in general than those with the lower nickel content.

The presence of about 1 per cent of lead in either alloy does not appear to affect the physical properties to any great extent.

As stated above, samples approximately 2, 4, 6 and 8 numbers (B. & S.) hard at 0.050-in. gage were obtained from each of the four alloys. Three tensile and three Erichsen specimens from each lot (making forty-eight tensile and forty-eight Erichsen specimens) were placed on a small pan 11 x 14 in. and carefully annealed in a nichrome wound electric muffle furnace 12 in. wide x 8 in. high x 28 in. deep. The temperature was controlled by means of a platinum thermocouple used in conjunction with an Engelhardt millivoltmeter. The specimens were annealed for half-hour periods at the temperature designated plus a preheating period averaging 1 hour and 17 minutes.

The physical test results are given in Tables V to VIII inclusive. The tensile test values are shown plotted against the temperature in Figs. 18, 19, 20 and 21.

The Erichsen ductility values and the scleroscopic

TABLE V. PHYSICAL TESTS OF ANNEALED MATERIAL

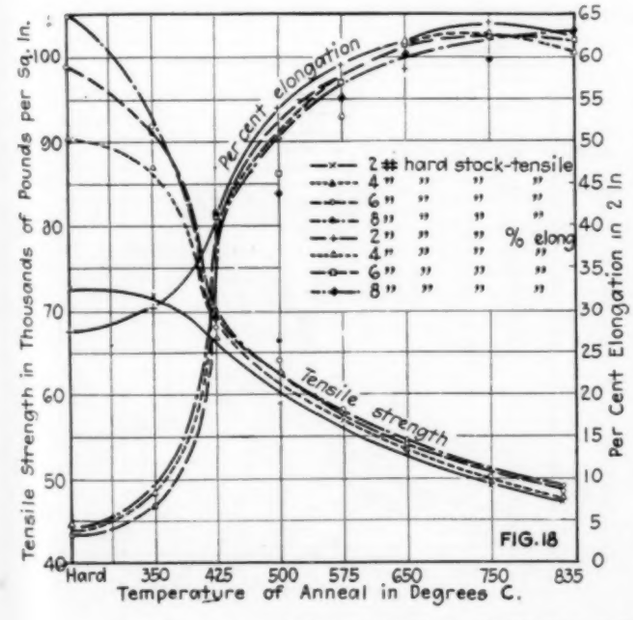
Alloy A—Analysis: Copper, 64.68 per cent; lead, trace; iron, 0.194 per cent; nickel, 6.73 per cent; manganese, 0.06 per cent; zinc, remainder.

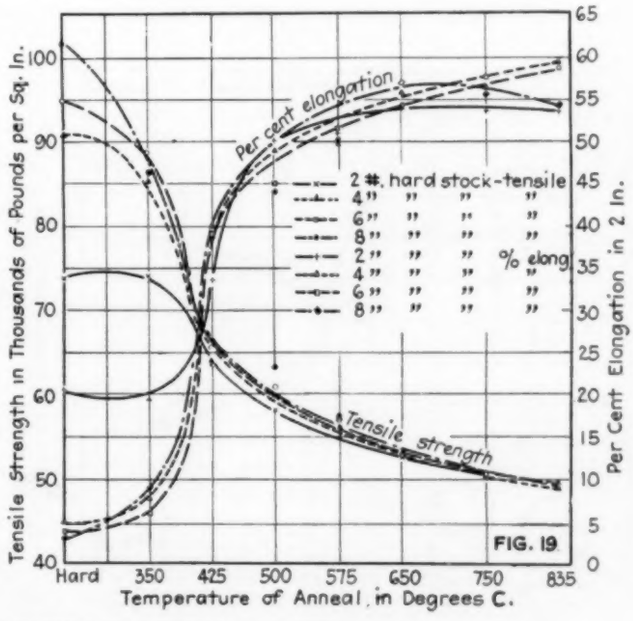
Treatment	Yield Pt., Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., 2 In.	Per Cent Red. Area	Erichsen Press., Lb.	Erichsen Press., Lb. per mm.	Erichsen Cup Depth, mm.	Scler.
Original Sample Reduced 19.55 Per Cent by Rolling:								
Original	53,267	72,667	27.8	49.3	5,263	586	8.97	30
350° C.	64,133	71,800	30.2	45.1	5,311	563	9.47	28
425° C.	45,866	66,100	39.8	52.7	5,573	636	8.76	22
500° C.	31,433	59,167	54.3	52.8	6,393	535	11.94	15
575° C.	26,667	56,700	59.2	54.6	6,364	528	12.07	13
650° C.	22,633	53,200	58.5	55.7	6,214	479	12.96	12
750° C.	20,633	49,133	64.0	54.3	5,796	451	12.85	10
835° C.	18,533	46,967	62.5	50.4	5,569	399	13.97	10
Original Sample Reduced 44.4 Per Cent by Rolling:								
Original	90,433	90,433	4.8	35.4	4,485	709	6.33	40
350° C.	82,267	87,100	8.5	33.7	4,576	673	6.80	39
425° C.	44,967	66,667	41.5	47.4	6,047	621	9.74	21
500° C.	38,000	62,567	50.7	49.2	6,294	591	10.66	18
575° C.	28,267	57,633	55.25	53.0	6,068	512	11.85	15
650° C.	22,033	53,367	62.0	55.5	5,689	453	12.57	11
750° C.	22,400	49,433	62.8	54.5	5,504	422	13.03	10
835° C.	17,667	47,400	60.3	53.2	5,320	397	13.39	10
Original Sample Reduced 51.9 Per Cent by Rolling:								
Original	99,167	99,167	3.5	29.5	2,140	645	3.33	42
350° C.	77,550	91,850	6.8	31.8	3,835	771	4.98	40
425° C.	44,900	67,900	41.2	49.6	6,383	638	10.01	22
500° C.	40,133	64,267	46.2	51.0	6,271	607	10.33	19
575° C.	28,367	57,733	57.0	51.7	6,053	520	11.66	15
650° C.	22,567	53,833	61.5	56.1	5,978	479	12.49	12
750° C.	21,033	49,933	62.3	53.5	5,588	438	12.75	10
835° C.	19,800	48,333	62.0	53.6	5,377	404	12.66	10
Original Sample Reduced 60.5 Per Cent by Rolling:								
Original	104,967	104,967	4.2	27.9	1,664	641	2.60	44
350° C.	74,767	91,133	8.8	34.5	3,704	760	4.87	40
425° C.	48,200	69,667	41.5	47.3	6,516	631	10.33	23
500° C.	42,800	66,333	44.2	48.2	6,543	636	10.29	20
575° C.	29,067	58,400	55.3	54.4	6,419	538	11.92	15
650° C.	21,633	53,666	62.7	56.9	6,180	499	12.38	12
750° C.	19,933	50,067	59.7	54.2	5,825	463	12.57	10
835° C.	20,233	48,867	63.7	54.4	5,611	414	13.55	10

TABLE VI. PHYSICAL TESTS ON ANNEALED MATERIAL

Alloy B—Analysis: Copper, 65.82 per cent; lead, 1.27 per cent; iron, 0.227 per cent; nickel, 6.17 per cent; manganese, 0.06 per cent; zinc, remainder.

Treatment	Yield Pt., Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., 2 In.	Per Cent Red. Area	Erichsen Press., Lb.	Erichsen Press., Lb. per mm.	Erichsen Cup Depth, mm.	Scler.
Original Sample Reduced 18.4 Per Cent by Rolling:								
Original	60,700	73,667	20.5	43.2	4,025	587	6.87	30
350° C.	66,533	74,233	19.5	48.0	4,049	566	7.14	30
425° C.	44,933	63,633	33.3	46.8	4,268	561	7.61	22
500° C.	29,200	58,300	50.2	56.8	5,648	506	11.17	15
575° C.	25,900	55,833	51.0	58.8	5,590	477	11.71	14
650° C.	23,267	53,600	54.0	59.7	5,525	459	12.05	12
750° C.	20,133	50,566	53.7	50.9	5,293	417	12.68	11
835° C.	20,833	49,533	53.75	49.4	5,330	407	13.12	10
Original Sample Reduced 44.4 Per Cent by Rolling:								
Original	90,850	90,850	4.8	33.7	1,864	504	3.71	37
350° C.	73,000	85,250	7.8	38.1	1,824	542	3.36	38
425° C.	40,833	64,033	40.0	51.6	5,182	550	9.42	21
500° C.	34,900	61,000	49.0	56.2	5,505	515	10.76	17
575° C.	27,767	56,000	50.0	56.7	5,420	477	11.36	15
650° C.	22,100	53,050	55.8	58.0	5,342	431	12.39	12
750° C.	21,467	50,900	58.25	57.8	5,300	405	13.09	11
835° C.	21,233	49,033	59.7	56.1	5,090	401	12.69	11
Original Sample Reduced 49.75 Per Cent by Rolling:								
Original	95,100	95,100	4.0	28.3	1,205	506	2.39	40
350° C.	71,200	88,733	6.0	35.0	1,346	518	2.60	40
425° C.	42,300	65,500	39.8	51.9	5,403	554	9.76	21
500° C.	34,033	61,033	45.0	52.0	5,390	527	10.23	19
575° C.	28,967	57,133	51.3	56.2	5,433	468	11.62	15
650° C.	21,600	53,233	54.2	55.1	5,130	444	11.57	12
750° C.	19,133	50 866	57.5	54.4	5,208	417	12.51	12
835° C.	19,333	49,000	58.7	54.8	5,188	397	13.05	11
Original Sample Reduced 59.75 Per Cent by Reduction:								
Original	101,633	101,633	3.3	23.1	1,014	446	2.28	42
350° C.	74,367	86,267	9.3	40.8	1,515	544	2.79	40
425° C.	43,867	66,567	38.8	52.9	5,493	601	9.15	22
500° C.	40,033	63,467	44.0	54.3	5,698	546	10.44	20
575° C.	29,033	57,200	50.7	56.9	5,613	481	11.68	15
650° C.	22,400	53,333	57.2	60.5	5,450	455	11.98	12
750° C.	19,433	50,700	55.7	58.1	5,358	416	12.89	12
835° C.	20,600	49,333	54.0	53.6	5,167	409	12.64	10


Tensile Strength in Thousands of Pounds per Sq. In.
Per Cent Elongation in 2 In.
Per cent elongation
Tensile strength
2 #, hard stock-tensile
4 " " " "
6 " " " "
8 " " " "
2 " " " % elong
4 " " " "
6 " " " "
8 " " " "
FIG. 18
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.


Tensile Strength in Thousands of Pounds per Sq. In.
Per Cent Elongation in 2 In.
Per cent elongation
Tensile strength
2 #, hard stock-tensile
4 " " " "
6 " " " "
8 " " " "
2 " " " % elong
4 " " " "
6 " " " "
8 " " " "
FIG. 19
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.

FIGS. 18 AND 19. PHYSICAL TESTS TAKEN ON ANNEALED STEEL.

Fig. 18—Alloy A. Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder. Original samples reduced 19.55, 44.4, 51.9 and 60.5% respectively. Fig. 19—Alloy B. Analysis: Copper, 65.82%; lead, 1.27%; iron, 0.227%; nickel, 6.17%; manganese, 0.06%; zinc, remainder. Original samples reduced 18.4, 44.4, 49.75 and 59.75% respectively.

hardness values are shown in plotted form in Figs. 34, 35, 36 and 37. It is interesting to note that these curves are very similar to the tensile strength and elongation curves of the preceding Figs. 18, 19, 20 and 21; the Erichsen curve parallels the per cent elongation curve, while the scleroscopic hardness curve is similar to the tensile strength curve.

Nickel silver is similar to brass with respect to its grain characteristics excepting that grain growth is retarded by the presence of nickel. Severely worked material with the lower nickel content—alloys *A* and *B*—shows a beginning of recrystallization at 350 deg. C., which is about 50 deg. C. higher than in the case of alpha brass. In the case of the nickel silvers with the higher nickel content—alloys *C* and *D*— the first signs of recrystallization on the hard-rolled specimens is observed at 500 deg. C.

The great differences in tensile strength, per cent elongation, etc., which are seen in the samples reduced various amounts by rolling are approximately equalized by an anneal at 425 deg. C. in the case of alloys *A* and *B* and at 575 deg. C. with alloys *C* and *D*.

Effect of Nickel on Tensile Strength and Elongation

Comparative tensile properties of the four alloys are shown in Fig. 38, which gives the annealing characteristics of material originally 4 numbers hard. It will be seen that the effect of nickel is to raise the tensile strength and lower the per cent elongation. This

TABLE VII. PHYSICAL TESTS OF ANNEALED MATERIAL.

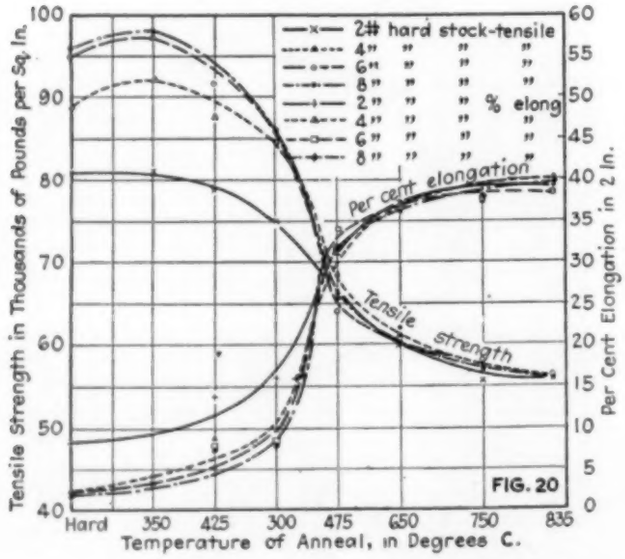
Alloy C—Analysis: Copper, 65.44 per cent; lead, trace; iron, 0.345 per cent; nickel, 17.83 per cent; manganese, 0.08 per cent; zinc, remainder.

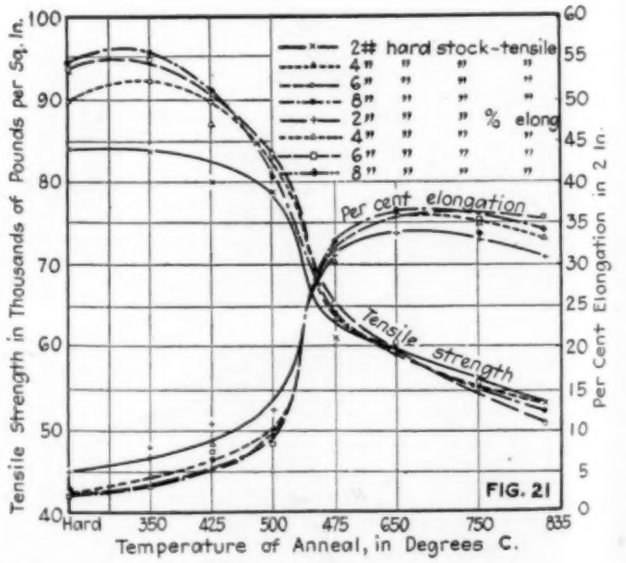
Treatment	Yield Pt., Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., 2 In.	Per Cent Red. Area	Erichsen Press., Lb.	Erichsen Press., Lb. per mm.	Erichsen Cup Depth, mm.	Scler.
Original Sample Reduced 16.6 Per Cent by Rolling:								
Original	67,000	80,766	8.0	40.7	4,712	574	8.21	32
350° C.	77,900	80,933	9.8	39.9	4,750	632	7.52	33
425° C.	70,233	78,433	13.7	40.0	4,875	604	8.07	29
500° C.	65,500	75,000	16.0	43.75	4,837	577	8.38	27.5
575° C.	46,566	66,660	30.7	44.6	4,865	553	8.80	20
650° C.	29,000	59,933	37.5	44.9	5,535	502	11.03	15
750° C.	24,067	55,567	37.3	45.7	5,433	498	10.92	14
835° C.	21,100	55,867	39.3	45.7	5,490	463	11.87	12
Original Sample Reduced 40.3 Per Cent by Rolling:								
Original	88,933	88,933	2.3	30.9	4,434	617	7.19	37
350° C.	89,600	92,300	4.2	33.7	4,248	693	6.13	37
425° C.	83,800	87,700	8.7	35.0	4,517	663	6.82	33
500° C.	79,300	84,567	9.8	38.9	4,499	629	7.17	33
575° C.	42,533	65,967	28.7	45.5	5,275	528	10.01	20
650° C.	30,667	61,067	37.0	49.8	5,142	504	10.21	15
750° C.	24,000	57,700	37.2	42.5	5,358	471	11.37	13
835° C.	21,767	55,900	40.3	44.6	5,237	434	12.06	12
Original Sample Reduced 52.7 Per Cent by Rolling:								
Original	95,000	95,000	2.3	30.8	3,555	688	5.16	38
350° C.	89,533	97,533	3.7	31.0	2,444	639	3.82	40
425° C.	87,133	91,667	7.7	35.3	3,932	710	5.56	35
500° C.	78,800	86,000	8.5	37.9	4,423	657	6.73	35
575° C.	39,333	64,266	34.3	49.3	5,418	534	10.15	18
650° C.	29,350	60,950	36.8	44.9	5,147	521	9.88	14
750° C.	26,750	57,800	37.8	44.7	5,300	473	11.21	14
835° C.	22,900	56,250	38.5	47.3	5,304	447	11.94	13
Original Sample Reduced 62.0 Per Cent by Rolling:								
Original	96,167	96,167	2.0	29.3	2,012	665	3.03	39
350° C.	96,633	98,333	3.2	30.5	1,794	642	2.79	41
425° C.	86,867	93,533	7.3	34.7	2,038	699	2.93	38
500° C.	80,200	85,933	8.2	37.5	4,316	685	6.30	35
575° C.	43,867	65,933	31.7	44.6	5,360	549	9.78	20
650° C.	34,300	62,067	36.3	44.3	5,420	526	10.30	16
750° C.	24,567	57,100	37.7	45.5	5,483	482	11.37	13
835° C.	22,067	56,167	39.8	43.6	5,368	442	12.15	12

TABLE VIII. PHYSICAL TESTS ON ANNEALED MATERIAL

Alloy D—Analysis: Copper, 65.60 per cent; lead, 1.08 per cent; iron, 0.238 per cent; nickel, 17.77 per cent; manganese, 0.06 per cent; zinc, remainder.

Treatment	Yield Pt., Lb. per Sq.In.	Ten. Str., Lb. per Sq.In.	Per Cent Elong., 2 In.	Per Cent Red. Area	Erichsen Press., Lb.	Erichsen Press., Lb. per mm.	Erichsen Cup Depth, mm.	Scler.
Original Sample Reduced 16.95 Per Cent by Rolling:								
Original	58,167	83,933	5.2	33.0	3,490	540	6.46	33
350° C.	82,600	83,533	8.2	33.2	3,761	723	5.21	33
425° C.	76,100	80,133	11.2	34.5	3,577	693	5.16	31
500° C.	72,767	79,000	12.7	34.7	3,783	683	5.54	29
575° C.	33,433	61,233	32.2	46.7	4,813	610	7.89	17
650° C.	29,933	60,233	34.2	48.1	5,036	574	8.77	15
750° C.	26,633	56,767	33.5	46.6	5,063	480	10.55	13
835° C.	21,533	53,500	31.3	45.8	4,980	454	10.97	11
Original Sample Reduced 42.4 Per Cent by Rolling:								
Original	90,100	90,100	2.5	28.7	1,513	458	3.31	36
350° C.	87,367	92,500	4.5	28.0	1,665	537	3.10	36
425° C.	83,467	87,167	8.5	29.5	1,915	625	3.07	35
500° C.	71,600	83,367	9.8	31.2	2,227	620	3.58	32
575° C.	38,733	63,733	30.7	45.3	4,843	605	8.01	18
650° C.	30,967	60,767	36.0	47.6	4,770	542	8.81	16
750° C.	25,633	55,800	35.5	46.8	4,745	450	10.55	13
835° C.	21,933	53,533	33.5	44.4	4,715	431	10.95	12
Original Sample Reduced 52.7 Per Cent by Rolling:								
Original	94,167	94,167	2.2	26.9	1,357	396	3.48	37
350° C.	84,550	95,333	3.3	25.9	1,369	662	2.07	38
425° C.	84,900	89,950	7.5	29.2	1,405	549	2.56	36
500° C.	74,467	83,400	8.7	32.0	2,702	693	3.95	33
575° C.	41,667	65,467	32.3	46.4	4,881	588	8.30	19
650° C.	30,333	60,800	36.2	46.0	4,531	551	8.23	15
750° C.	24,900	56,133	35.7	48.0	4,781	445	10.75	13
835° C.	21,767	51,433	36.2	46.8	4,600	433	10.62	12
Original Sample Reduced 62.5 Per Cent by Rolling:								
Original	94,533	94,533	2.0	24.0	1,261	517	2.45	38
350° C.	95,900	95,900	2.7	23.1	1,164	580	2.01	40
425° C.	86,400	91,333	6.7	26.6	1,236	578	2.14	36
500° C.	72,433	80,867	9.5	32.9	2,823	651	4.34	33
575° C.	40,250	63,800	33.0	47.7	4,927	594	8.30	18
650° C.	28,950	59,600	36.8	46.8	4,857	497	9.79	15
750° C.	24,333	55,767	34.2	47.5	4,759	451	10.55	13
835° C.	21,367	52,700	34.5	46.6	4,707	430	10.95	12

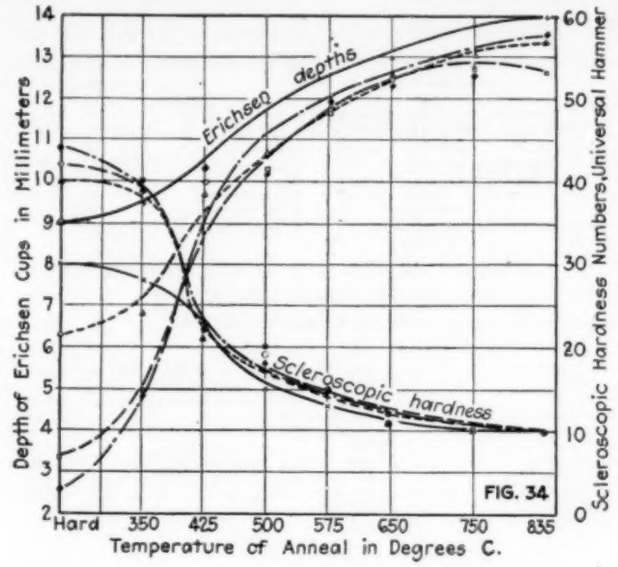

2# hard stock-tensile
4" " " "
6" " " "
8" " " "
2" " " % elong
4" " " "
6" " " "
8" " " "
Per cent elongation
Tensile strength
Tensile Strength in Thousands of Pounds per Sq. In.
Per Cent Elongation in 2 In.
Hard 350 425 300 475 650 750 835
Temperature of Anneal, in Degrees C.
FIG. 20

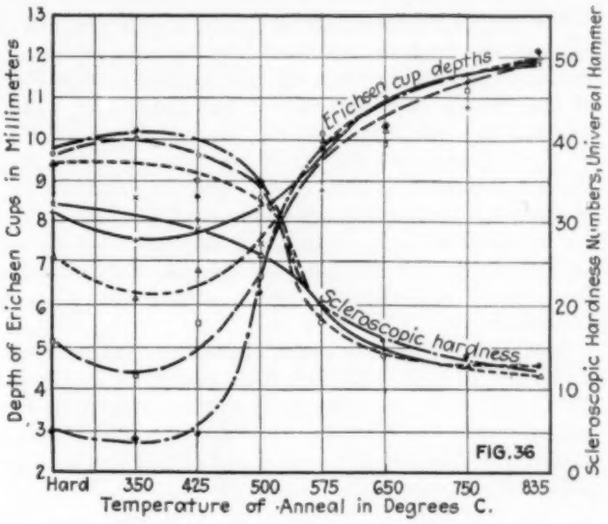

2# hard stock-tensile
4" " " "
6" " " "
8" " " "
2" " " % elong
4" " " "
6" " " "
8" " " "
Per cent elongation
Tensile strength
Tensile Strength in Thousands of Pounds per Sq. In.
Per Cent Elongation in 2 In.
Hard 350 425 500 475 650 750 835
Temperature of Anneal, in Degrees C.
FIG. 21

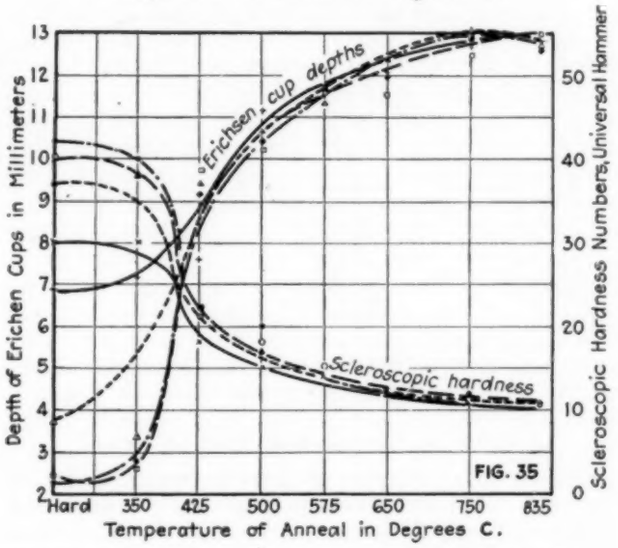
FIGS. 20 AND 21. PHYSICAL TESTS TAKEN ON ANNEALED MATERIAL

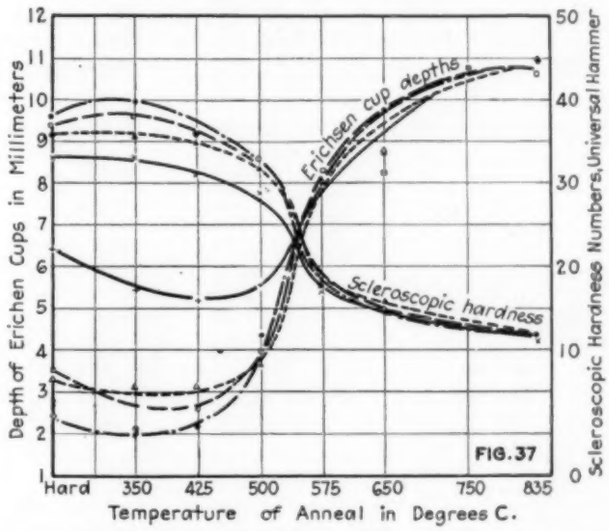
Fig. 20—Alloy C. Analysis: Copper, 65.44%; lead, trace; iron, 0.345%; nickel, 17.83%; manganese, 0.08%; zinc, remainder. Original samples reduced 16.6, 40.3, 52.7 and 62.0% respectively.

Fig. 21—Alloy D. Analysis: Copper, 65.60%; lead, 1.08%; iron, 0.238%; nickel, 17.77%; manganese, 0.06%; zinc, remainder. Original samples reduced 16.95, 42.4, 52.7 and 62.5% respectively.


Depth of Erichsen Cups in Millimeters
Scleroscopic Hardness Numbers, Universal Hammer
Erichsen depths
Scleroscopic hardness
FIG. 34
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.


Depth of Erichsen Cups in Millimeters
Scleroscopic Hardness Numbers, Universal Hammer
Erichsen cup depths
Scleroscopic hardness
FIG. 36
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.


Depth of Erichen Cups in Millimeters
Scleroscopic Hardness Numbers, Universal Hammer
Erichsen cup depths
Scleroscopic hardness
FIG. 35
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.
2# hard stock, scler.
4" " " "
6# hard stock, scler.
8" " " "


Depth of Erichen Cups in Millimeters
Scleroscopic Hardness Numbers, Universal Hammer
Erichsen cup depths
Scleroscopic hardness
FIG. 37
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.
2# hard stock, Erichsen
4" " " "
6# hard stock, Erichen
8" " " "

FIGS. 34 TO 37. ERICHSEN DUCTILITY AND SCLEROSCOPE HARDNESS TESTS

Fig. 34—Alloy A, annealed series. Fig. 35—Alloy B, annealed series. Fig. 36—Alloy C, annealed series. Fig. 37—Alloy D, annealed series.

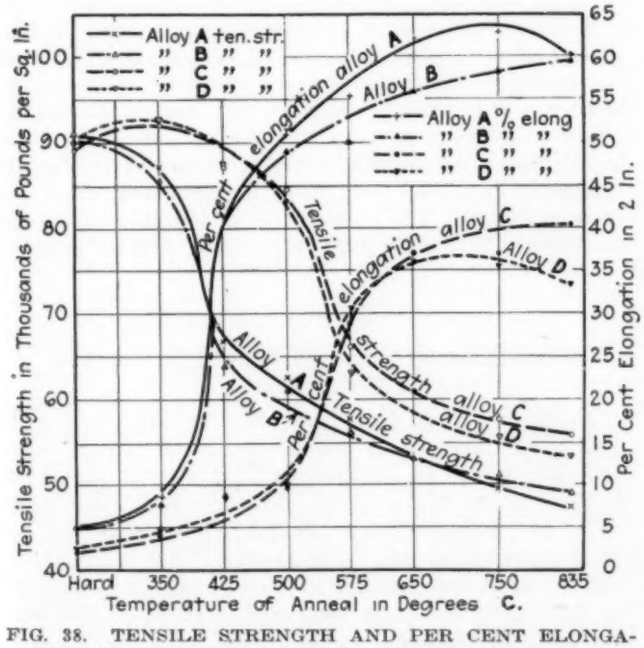

Tensile Strength in Thousands of Pounds per Sq. In.
Per Cent Elongation in 2 In.
Alloy A ten. str.
" B " "
" C " "
" D " "
Alloy A % elong
" B " "
" C " "
" D " "
Per cent elongation alloy A
Alloy B
Tensile elongation alloy C
Alloy D
Alloy A
Alloy B
Per cent Tensile strength alloy C
alloy D
Tensile strength
Hard 350 425 500 575 650 750 835
Temperature of Anneal in Degrees C.

FIG. 38. TENSILE STRENGTH AND PER CENT ELONGATION OF ANNEALED SAMPLES ALLOYS A, B C AND D, PREVIOUSLY ROLLED 4 NUMBERS HARD

specifically higher initial strength and lower elongation are evidently not unfavorable from the cold-working standpoint, as indicated by the behavior of the metal in practice when subjected to severe reduction by rolling.

Microstructure

Representative micrographs of the structures of alloys *A* and *C*, originally about 6 numbers (B. & S.) hard, are shown in Figs. 22 to 33 inclusive. Referring to Fig. 23, it will be seen that alloy *A* shows incipient recrystallization after an anneal at 350 deg. C. At 425 deg. C. the recrystallization is complete (Fig. 24). The grains grow as the temperature rises, but it is clear that the grain size is consistently smaller than that of brass treated in a similar way. Referring to Fig. 30, it is apparent that partial recrystallization of alloy C has begun at 500 deg. C., while complete recrystallization first occurs at 575 deg. C. (Fig. 31.)

These micrographs illustrate very clearly that in order to attain a given grain size the 18 per cent nickel silver requires an annealing temperature about 100 to 150 deg. C. higher than will suffice in the case of the 7 per cent alloy.

Scovill Manufacturing Co.,
Waterbury, Conn.

Statistics of Fats and Oils, First Quarter, 1921

The factory production of fats and oils (exclusive of refined oils and derivatives) during the three-month period ended March 31, 1921, as compiled by the Bureau of the Census, was as follows: Vegetable oils, 652,230,449 lb.; fish oils, 1,037,781 lb.; animal fats, 512,557,342 lb.; and grease, 89,312,244 lb.; a total of 1,255,137,816 lb. Of the several kinds of oils and fats covered by the inquiry the greatest production, 481,778,873 lb. appears for cottonseed oil. Next in order, edible and neutral lard with 430,238,669 lb.; linseed oil with 118,786,819 lb.; tallow with 80,989,879 lb. and coconut oil with 23,062,246 lb.

Nearly all the crude vegetable oils are passed through a refining process, although some virgin oil is expressed. The production of refined oil during the three-month period was as follows: Cottonseed, 424,315,821 lb., coconut, 36,554,004 lb.; peanut, 6,523,996 lb.; soya bean, 2,289,969 lb., and corn, 11,550,768 lb.

The data for the production, consumption, imports, exports and stocks of fats and oils and for the raw materials used in the production of vegetable oils for the three-month period appear in the following statements:

PRODUCTION, CONSUMPTION AND STOCKS OF FATS AND OILS

Kind	— For the Quarter Ending — March 31, 1921 Production, Lb.	Consumption, Lb.	Stocks Held March 31, 1921 Lb.
Vegetable oils:			
Cottonseed, crude	481,778,873	459,679,817	166,077,770
Cottonseed, refined	424,315,821	203,997,084	367,232,310
Peanut, virgin and crude	6,825,456	11,213,049	18,847,639
Peanut, refined	6,523,996	11,941,597	5,375,502
Coconut or copra, crude	23,062,246	61,531,261	65,447,081
Coconut or copra, refined	36,554,004	41,586,031	19,644,349
Corn, crude	15,669,550	13,394,679	5,469,271
Corn, refined	11,550,768	1,514,742	9,160,609
Soya-bean, crude	.....	9,215,295	17,135,825
Soya-bean, refined	2,289,969	5,400,691	3,699,120
Olive, virgin and crude	763,495	402,702	6,229,106
Olive, refined	59,425	160,328	1,526,717
Palm-kernel, crude	1,327,382	241,228	1,908,419
Palm-kernel, refined	.....	163,120	58,414
Rapeseed	15,000	1,602,763	3,648,241
Linseed	118,786,819	38,134,250	122,307,905
Chinese wood or tung	.....	5,918,985	15,417,919
Castor	3,611,809	1,024,043	4,786,270
Palm	.....	4,818,493	4,407,777
Chinese vegetable tallow	.....	682,068	681,260
All other	389,819	3,407,179	5,439,460
Fish oils:			
Cod and cod-liver	116,328	937,894	2,141,980
Menhaden	.....	8,206,843	27,516,534
Whale	64,500	1,066,907	10,810,825
Herring	86,412	157,518	2,623,027
Sperm	43,046	191,673	6,684,816
All other (including marine animal)	727,495	633,104	3,518,812
Animal fats:			
Lard, neutral	21,245,978	8,026,511	9,953,106
Lard, other edible	408,993,291	64,286,516	115,467,838
Tallow, edible	8,569,272	5,913,233	5,303,491
Tallow, inedible	72,420,007	74,920,537	97,682,401
Neat's-foot oil	1,328,794	292,423	1,618,596
Greases:			
White	18,723,511	6,889,201	10,865,556
Yellow	12,156,352	8,155,827	11,117,985
Brown	8,334,846	7,650,765	14,226,646
Bone	5,957,916	1,072,700	8,048,759
Tankage	24,464,559	3,672,115	17,265,825
Garbage or house	14,114,330	7,529,025	24,407,150
Wool	1,050,341	305,483	1,547,791
Recovered or degras	3,211,420	1,990,522	2,512,392
All other	1,298,969	802,428	4,641,109
Derivatives:			
Acidulated soap stocks	14,419,846	12,915,898	17,382,636
Cottonseed foots	43,695,487	35,471,562	27,187,928
Cottonseed foots (distilled)	3,890,287	1,788,555	7,922,627
Other vegetable foots	5,033,019	4,399,665	1,979,257
Other vegetable foots (distilled)	.....	5,250	413,804
Fatty acids	18,521,429	19,104,682	8,567,362
Fatty acids (distilled)	19,197,121	11,322,009	7,278,768
Glycerin, crude 80% basis	12,255,577	10,787,416	7,003,260
Glycerin, dynamite	4,567,373	7,024,796	10,138,412
Glycerin, chemically pure	6,652,993	446,787	4,484,220
Hydrogenated oil	42,404,313	13,607,919	32,189,758
Lard oil	3,294,700	1,300,137	4,155,778
Oleo oil, edible	39,227,067	11,025,343	25,091,827
Red oil	6,145,547	3,443,295	8,472,902
Stearic acid	4,076,405	1,186,976	7,303,013
Animal stearin, edible	19,497,413	11,610,325	7,705,704
Animal stearin, inedible	2,104,796	5,086,544	4,491,623
Tallow oil	2,146,926	6,805,915	3,005,558
Vegetable stearin	5,508,227	4,755,636	3,803,221
Miscellaneous soap stock	255,866	4,556,726	2,759,368

Note.—In some cases products are prepared by a continuous process, and intermediate products, which sometimes appear on the market under their own names are not reported.

RAW MATERIALS USED IN THE PRODUCTION OF VEGETABLE OILS

Kind	— Tons of 2,000 lb. — Consumed Jan. 1 to Mar. 31	On Hand Mar. 31	Kind	— Tons of 2,000 Lb.— Consumed Jan. 1 to Mar. 31	On Hand Mar 31
Cottonseed	1,478,606	299,976	Olives	2,567	30
Peanuts (hulled)	2,822	4,021	Flaxseed	177,611	30,063
Peanuts, in the hull	8,889	48,425	Castor	3,829	2,879
Copra	17,372	3,100	Mustard seed	943	1,102
Coconuts and skins	256	111	Palm kernel	978	.....
Corn germs	22,978	441	Other kinds	93	82

IMPORTS AND EXPORTS OF FATS AND OILS

(For the quarter ended March 31, 1921)

Imports of Foreign Fats and Oils

Kind	Lb.	Kind	Lb.
Cottonseed oil	438,241	Sulphur oil or olive foots	1,010,814
Coconut oil	44,846,135	Other vegetable oils (value)	86,542
Peanut oil	576,510	Cod and cod-liver oil	1,346,115
Soya-bean oil	3,121,903	Tallow	64,366
Olive oil, inedible	317,175	Oleo stearin	60
Olive oil, edible	3,788,242	Glycerin, crude	436,648
Rapeseed oil	1,997,130	All other animal	400,905
Chinese-nut oil	4,062,578	Greases not elsewhere specified	3,714,996
Linseed oil	554,235		
Palm oil	6,654,536		
Palm kernel	145,614		

Exports of

Domestic Fats and Oils — Kind	Lb.	Foreign Fats and Oils — Kind	Lb.
Cottonseed oil	146,178,632	Coconut oil	633,493
Coconut oil	1,259,888	Cottonseed oil	3,750
Soya-bean oil	1,363,186	Olive oil	45,165
Peanut oil	425,008	Soya-bean oil	62,200
Linseed oil	1,177,658	Palm oil	72,804
Corn oil	1,011,464	Peanut oil	76,560
Other vegetable oils (value)	$174,731	Chinese-nut oil	182,678
Vegetable stearin	997,737	Sulphur oil or olive foots	43,689
Fish oil	146,595	Other vegetable oils (value)	$13,885
Lard, edible	250,642,768	Cod and cod-liver oil	30,382
Lard, neutral	7,535,276		
Tallow	3,178,705		
Oleo oil	32,687,123		
Lard oil	266,872		
Other animal oils	723,285		
Animal stearin	5,520,464		
Glycerin	380,857		
Soap stock and other greases (value)	$1,060,417		

Alcohol as Locomotive Fuel in Brazil

Consul C. R. Cameron, of Pernambuco, reports that there are in his district approximately 80 modern cane-sugar factories, which have about 800 miles of railway, of from 0.75 to 1 meter gage, operated at present by wood-burning locomotives. The fuel problem, however, is becoming a serious one and as a result the sugar-mill operators are turning their attention to the matter of reducing wood consumption and finding substitutes. Consequently great interest is being shown in the substitution of alcohol, which is produced in large quantities on the sugar plantations from the molasses finals. Pernambuco has recently adopted the use of alcohol to which 5 per cent gasoline has been added as an automobile fuel. The manufacturers are, therefore, naturally interested in using their own inexpensive product for their railways. The current price of alcohol is about $0.22 per gallon, but the cost to the producer is much less.

Production of Sugar in France During the 1920-21 Season

A recent report from the office of the commercial attaché at Paris states that the total quantity of sugar delivered by the 72 factories in France from September 1, 1920, to the end of April, 1921, reached, 294,260,142 kilos, as compared with 156,377,837 kilos during the corresponding season of the previous year. The stocks remaining at the factories at the end of April amounted to 25,338,609 kilos, as compared with 6,977,050 kilos for the previous year.

The Dependence of the Lime Industry Upon Nature and Science*

An Essay Upon the Occurrence of Calcium Carbonate in Nature and Upon the Origin of the Limestone Deposits Which Form the Basis of the Lime Industry—Indebtedness of the Industry to Science—Technical and Personnel Research Problems

BY ARTHUR D. LITTLE

A BUSINESS which consists essentially of quarrying and burning one of our commonest rocks and barreling and distributing the product does not at first sight seem to involve much of either science or romance. I hope to be able to convince you that it is replete with both.

In its relation to your business you think of limestone as the raw material of lime and are prone to overlook the fact that it is in reality an ore, and a most abundant one, of the metal calcium. The freshly-cut surface of the latter has a brilliant silvery luster, which upon exposure to the air is quickly dulled by the rusting or oxidation of the metal to its oxide, lime, from which through the Latin, *calx, calcis*, the metal takes its name. It is obviously one of the alkaline earth metals and closely resembles barium and strontium and to a lesser degree magnesium. Its specific gravity is about 1.5; it melts at about 800 deg. C. and it burns in the air with a white light to lime. It combines directly with most elements, including even nitrogen, with which it forms a nitride which, upon contact with water, evolves ammonia. A ton of pure limestone contains approximately 800 lb. of the metal, and chemically pure lime is over 70 per cent calcium. Science will ultimately find broad uses for a metal so interesting and abundant. It was discovered in 1806 by Sir Humphry Davy, who obtained an amalgam of calcium by the electrolysis of a mixture of lime and mercuric oxide. It remained a laboratory curiosity until 1900 and even as late as 1904 was quoted at £110 a pound. A year later an improved electric process brought the price to 12 shillings a kilo, or about $1.30 a pound.

The Various Forms of Calcium Carbonate

CALCITE

Calcium carbonate, or carbonate of lime, exhibits in its various occurrences an extraordinary number of protean aspects. As calcite it is, next to quartz, the most widely distributed of minerals and notable for the beauty and remarkable variety of its crystalline forms. A number of highly important optical instruments, like the polariscope used for testing sugar, derive their usefulness from the property of double refraction possessed by calcite in the form of Iceland spar. For many years the world derived its supply of these crystals of suitable optical quality from a single quarry, a cavity in basalt in Iceland, 12 yd. long by 5 yd. wide and 10 ft. high, which yielded enormous crystals, some a yard in length.

Carbonate of lime is soluble in water containing carbonic acid gas, but is deposited from solution when the gas escapes. By the drip of water so charged there are built up in caves the deposits in widely fantastic shapes of stalactites and stalagmites. Carbonated springs in limestone districts may become so highly impregnated with lime as to build up terraces and basins of remarkable beauty by its subsequent deposition. Those at Mammoth Hot Springs in Yellowstone Park are doubtless familiar to many of you. Mexican onyx is another variety, and a vast deposit at Tivoli supplied much of the building stone for ancient Rome. The alabaster of the Orient was stalagmitic limestone.

LIMESTONE AND ITS ORIGIN

But ignoring such exceptional forms and speaking generally, all limestone is of organic origin, the result of the life processes of inconceivable myriads of animal organisms, and the story of its formation is at once a triumph and romance of science.

When I was a boy in Portland, Me., I spent much of my time in studying the marine life of the harbor; the starfish and anemones on the piles beneath the wharves; the sea urchins, whose projecting spines showed in section under the microscope a limestone mosaic of such wonderful symmetry and color as to make me realize for the first time how much the world contains of beauty that is hidden from most eyes; the jellyfish, big ones with sweeping tentacles and tiny ones with opalescent bands of waving cilia; the barnacles with their rhythmical projection of feathery hands in search of food. A dredge, dragged on the bottom behind my boat, brought up many treasures: among them none more wonderful than the fragile, beautifully constructed, chambered, calcareous shells of foraminifera with perforated walls. So tiny were they that a hand glass and much pains were needed for their separation, and their exquisite details of structure were revealed only under the higher powers of the microscope.

Now it is bad enough to call such tiny creatures foraminifera, but I must even ask you to remember that the commonest of them is further burdened with the more distinctive name of globigerina, for the globigerina are at least as directly concerned in the business of making lime as any of you here.

CHALK BEDS

If you rub down a piece of chalk to a thin paste with water you will find upon microscopical examination that it is composed almost entirely of the shells of foraminifera, and some common chalks are built up almost wholly of globigerina shells. Such are the chalk beds of England, which, often more than a thousand feet in thickness, extend across the island for 280 miles and at the coast line rise in those white cliffs to which

*Address delivered at the third annual convention of the National Lime Association, New York, June 16, 1921.

England owes her name of Albion. But the chalk bed stretches far beyond the coast of England, over much of France, through Denmark and Central Europe, south to Africa, and even into Central Asia. In our own country true chalk is found in Kansas, Iowa, Texas and elsewhere. As localities change, however, other types of foraminifera than globigerina become predominant in its substance. Thus the miliola, so called from its resemblance to millet seed, has built up the enormous beds of limestone in the vicinity of Paris. Certain beds of carboniferous limestone in Russia are entirely made up of the remains of another and peculiar type of foraminifera, spindle-like in shape and called because of that fusulina.

Nummulitic Limestone

The Latin word for a coin was *nummus* and for a reason which will presently appear it gives its name to the nummulitic limestones, which extend over vast areas of North America and in a band often 1,800 miles in breadth and of enormous thickness from the Atlantic shores of Europe and Africa through western Asia to northern India and China. Of it the pyramids were builded, and from it was quarried and chiseled that memorial of antiquity, Cleopatra's Needle, which stands in Central Park.

This variety of limestone has been formed by the slow accretion of innumerable billions of the shells of foraminifera of the genus nummulites, which is characterized by shells of an extraordinary complexity of structure and a disk or coinlike form. They are remrkable also for their relatively vast size, the usual range of which is from one-half inch to an inch in diameter, though many are as large as a half-dollar and some even 4½ in. across. The significant fact is that, like the globigerina and other foraminifera, the nummulites are marine animals, and the genus is still represented, though by smaller types, in the ocean life of today.

Chalk is now forming on the ocean bottom, and there has been an unbroken continuity of chalk formation from Cretaceous times until now, while through the ages continents slowly rise.

Beneath that portion of the ocean which we call the North Atlantic lies a vast unbroken plain, which stretches from east to west for 1,700 miles. The mud and ooze brought up by dredges dragged along this plain consist almost entirely of globigerina shells or fragments of them; the tiny creatures passing their life cycle in the ocean depths where they are found. Here and elsewhere on the globe the globigerina ooze is forming chalk over 50,000,000 square miles of ocean bottom at an average depth of 2,000 ft. The overwhelming evidence is, therefore, that limestone, wherever found, is the product of aquatic life. Its common occurrence and broad distribution in the rock structure of the continents is proof that the regions of its occurrence were once beneath the sea, from which it has slowly emerged with the uplift of the land.

To those of you who think that science lacks poetry or romance or that the common things of life make no appeal to the imagination, I commend this passage from Huxley's lecture "On a Piece of Chalk":

> Thus there is a writing upon the wall of cliffs at Cromer, and whoso runs may read it. It tells us, with an authority which cannot be impeached, that the ancient sea-bed of the chalk sea was raised up, and remained dry land, until it was covered with forest, stocked with the great game whose spoils have rejoiced your geologists. How long it remained in that condition cannot be said; but "the whirligig of time brought its revenges" in those days as in these. That dry land, with the bones and teeth of generations of long-lived elephants hidden away among the gnarled roots and dry leaves of its ancient trees sank gradually to the bottom of the icy sea, which covered it with huge masses of drift and boulder clay. Sea-beasts, such as the walrus, now restricted to the extreme north, paddled about where birds had twittered among the topmost twigs of the fir-trees. How long this state of things endured we know not, but at length it came to an end. The upheaved glacial mud hardened into the soil of modern Norfolk. Forests grew once more, the wolf and the beaver replaced the reindeer and the elephant; and at length what we call the history of England dawned.

Coral Islands and Reefs

But we do not look alone to the chalk for the origin of limestone. Its formation is still proceeding on the grand scale through the agency of the coral polyp in many of the warmer waters of the globe. Two and a half million square miles of ocean bottom is covered with coral mud and sands. The gigantic structures of the coral islands and the barrier reefs, of which one extends for a thousand miles along the Australian coast, are the work of tiny bits of animated jelly, which abstract lime from the sea water and so deposit it that it reproduces their own radiated anatomy. A similar type of limestone, which is well represented by the coral reef at Alpena, Mich., is the product of bryozoa, compound coral-like animals that are regarded as primitive mollusks. They build frondlike structures, developing ultimately into reefs and limestone.

Much of the history of the earth and much of the effort of the living organisms which it has borne is thus written into the material on which the lime industry is based. All the structural works of man fade into nothingness when compared with the results of the life activities of the minute foraminifera and the coral polyp.

Pearls

The amazing capacity of carbonate of lime to assume forms of varied character and often of surpassing beauty is its most striking characteristic. The pearly shell of the chambered nautilus inspired Holmes to write one of the most elevating poems in the language. In the hope of securing a few grains of carbonate of lime rounded to form a pearl great companies of men shorten their lives by groping at the bottom of the sea. Curiously, the oyster forms the pearl around the dead body of an invading parasite so that, as a French writer has said, the ornament associated in all ages with beauty and riches is nothing but the brilliant sarcophagus of a worm. For myself, I prefer to derive encouragement from the fact that even so lowly a creature as the oyster can rise superior to misfortune and convert his troubles into pearls. It will interest you to know that in the Peabody Museum at Cambridge are pecks of fresh-water pearls which our Indians or their predecessors had thrown on sacrificial fires and that even today seed pearls are calcined in India and China for lime to prepare the betel nut for chewing.

Marble

In its metamorphosed form of marble, which, by the way, has given its name to one of the most ancient of children's games, limestone exhibits the widest possible range of texture, color and degree of purity. The marble from Mt. Pentelicus at Athens was chiseled by Greek

sculptors into forms that remain unrivaled in their classic beauty. Unhappily, much of the best Greek sculpture and architectural detail was broken up by the Turks and burned for lime. The finest works of Michael Angelo and Canova are executed in that other famous marble from Carrara. The onyx marble of Algeria was largely used in the buildings which were the glory of Carthage and of Rome. It is clouded with yellow and brown, like that found in Mexico at Tecali in large deposits. Wrought into the exquisite structure of the supremely beautiful Taj Mahal, marble gleams in the moonlight and is reflected in the pool like the fabric of an artist's dream.

A piece of limestone lying in the quarry seems a crude and simple thing, but when its history and associations are even thus partially reviewed, we find it something elaborate and complex, and rich in interest and suggestion.

Science and the Lime Industry

Similarly, the process of burning lime is at first sight a simple operation, which was successfully carried out for many centuries before the world had heard of science. It involves, nevertheless, a highly complicated series of molecular motions, changes and forces, which can be controlled to best advantage only through the agency of science. The results obtained on burning are influenced by many factors, such as the proper sizing of the limestone charge, the chemical composition of the stone, its physical structure, porosity and grain, the nature of the fuel, its heating power and sulphur content, the extent of the combustion area and the composition of the gases leaving the kiln, the volume of air admitted, the temperature of the several zones within the kiln, the flow of gases and the counter movement of the lime, the rate of cooling, the conditions of heat transference, the distribution of incoming air, and all the variations in kiln design. These are all factors which science can control. It can also produce accurate information as to the quality of the product for the aim in view.

Markets for Lime Developed by Science

It is one thing to make good lime, but quite a different thing to find a market for it. The creation of the broad market which exists in normal times is due in large measure to scientific research. There was a time when practically the only outlet for lime was through the mortar bed. Today its use for building purposes accounts for only 28½ per cent of the lime produced for sale in the United States. About 12 per cent more goes to agriculture, the total thus accounted for being only 40 per cent. The allotment of the remaining 60 per cent is distributed among forty-one separate items, and if from them we omit the single item of calcimine, every one is available as the direct result of modern chemical research.

Let us devote a moment to a demonstration of the thesis:

The pulp and paper mills are now credited with using over 10 per cent of the domestic production of lime. They do so because Watt and Burgess developed the soda process for pulping wood, which requires lime to causticize the soda ash; because Tilghman studied the action of solutions of calcium bisulphite on wood chips and gave the world the sulphite process, by which 14,000 cords of wood are daily reduced to fiber in the sulphite pulp mills of the country. The alkali works consume 145,000 tons of lime a year[1] because Leblanc, during the stress of the Napoleonic wars, sought and found the first cheap process for making alkali from salt and because Solvay by refined investigation developed that other method, by which salt, dissolved in strong ammonia water, is precipitated as bicarbonate of soda when the solution is charged with carbonic acid gas. In the course of the reaction the ammonia is converted into chloride, from which it is recovered by digestion with lime. Eighty-seven thousand tons goes to calcium carbide because the researches of Willson enriched the world by cheap carbide and acetylene, to which those of Franck added cyanamide. Thousands of tons of lime goes to the market as bleaching powder because Tennant solved the problem of fixing chlorine in a form convenient for transportation. Equally as the result of chemical research, lime is used in sugar factories and ammonia works, by the makers of soap and silica brick and phenol, in the gas works and at the coke oven, by makers of explosives and by the distillers of wood.

Technical Problems of the Industry

Fortunately for its continued progress, the lime industry is beset with many problems. In their solution lies the opportunity of the sagacious members of this association. The burning of lime is a chemical operation, and most of the problems connected therewith are fundamentally chemical problems, for the solution of which you must ultimately look to the chemist or chemical engineer. Why is it generally believed that wood is the best fuel for lime burning? Is it because its chemical composition and physical character confer upon it any singular property as a combustible? Or is it merely because it has been found to be foolproof? Now with wood rapidly becoming less and less available, how should the practice be changed to make available the much greater heating power of coal? If sulphur in coal is really seriously objectionable in its influence on operations, how may the sulphur be eliminated or its deleterious effect avoided? Doubtless we are still far from the ultimate design of kilns, but that ultimate design will not be reached until the physical chemist is taken into partnership, for it is the laws of physical chemistry that determine the effectiveness of such design.

Still more obviously must chemical research be depended upon for the better control of the quality and characteristics of the product and the elimination of those anomalies which are now the cause of irritation and complaint. Since 60 per cent of the country's production of lime is utilized for chemical purposes, it is especially important to consider more carefully the actual availability for such purposes of the lime that is produced. Of two limes it often happens, for example, that not over 80 per cent of the actual calcium oxide content of the lime as furnished is satisfactorily available within a reasonable period of time as a causticizing agent. The remainder seems to be sintered together by overheating or in combination with impurities. Of two limes apparently identical one may absorb 25 per cent more chlorine than the other. They may show radical differences when used in the causticizing plants. One may effect a quick reaction, forming a precipitate that settles rapidly, while the use of the other may be

[1] This figure represents only lime sold to alkali works. In addition, about 1,500,000 tons of lime a year is produced by the alkali manufacturers for their own use.

impracticable because of the nature of the precipitate and its slow rate of settling. If used in the tanning industry for dehairing hides, one may be very active, while the other lime of identical analysis may require considerable excess to accomplish the same work. Lime from one locality may cause much trouble from irritation of the skin and the throats of workmen in the hydrate mill, whereas in other sections the dust in the air of the hydrate mill handling lime of practically identical chemical analysis has little or no such effect upon the workmen.

Plasticity a Fundamental Physical Property of Lime

In many instances it is not so much the chemical as the physical properties of the lime that determine its availability for special purposes. This is especially true as regards the proportion of lime putty formed and the plasticity or amount of sand the lime will carry when used by the building trades. Research alone can determine the fundamental cause of this variation—whether it is due to differences in size of particles, crystal structure, the presence of colloidal impurities, or what not. The problem is especially difficult to attack because of the lack of a definite and satisfactory measure of plasticity, for until we can measure a property accurately we cannot determine what tends to augument or decrease that property. Mere trial by an experienced plasterer will not yield the kind of evidence which leads to progress. It may even, I think, be questioned whether the newly developed plasticimeter of the Bureau of Standards is, after all, more than a refined and excellent practical test. Prof. Bingham of Lafayette more nearly approaches the fundamental problem when he separates plasticity into its two essential factors—mobility and yield point—and brings order out of the hazy chaos which has hitherto enveloped the word "plasticity."

Factors Influencing the Progress in the Lime Industry

Research in modern industry is somewhat like a highly complicated and sensitive mechanism. It will not function properly unless care is taken in choosing the men who are to conduct it: not so much from the standpoint of their general qualifications as scholars, scientists and engineers as from the standpoint of their ability to unite into one compact body the various elements essential to constructive thinking plus its application in a concrete way in specified cases.

In the lime industry notable progress has been made in the design of kilns and in the mechanical features involving the transportation of materials from one point to another. A modern limekiln is a highly sensitive organ, which must be treated with proportionate care if results that measure its true ability are to be obtained. It is the result of careful research and stands today not as an experiment, but as a proved illustration of the value of modern research in industry. Although operating data are hard to obtain on kilns of earlier types, it is not unreasonable to suppose that a ratio equivalent to 2 lb. of lime per lb. of coal used would have been regarded as a highly efficient one. Today modern kilns properly operated often do better than 6 lb. of lime per lb. of coal over long-range periods of operation. Although the historic lime burner may have gathered his fuel from the surrounding woods at a cost which, to him, was measured by the amount of energy personally expended, the cost to civilization in the long run has to be calculated on the basis of carbon content of the matter actually destroyed in the process. We may fairly say then that modern development in limekilns has done its bit to conserve the existing fuel supplies of the world and produce a product at a much decreased economic cost.

Personnel

But it is not enough to have a highly developed instrument without adequate mentality to guide and control it. The type of lime superintendent of today is often a man who has come up through thirty years of rapidly changing conditions and is frequently disposed to regard refinements and developments with an austere eye, largely because he does not understand them. Their conception is fundamentally so different from his point of view that it is very difficult, if not impossible, for him to change his attitude of mind. The abuse of modern kilns in some instances has been so marked that one of the most prominent individuals in the lime industry today states emphatically that he prefers engineers who have never seen a lime plant in operation for technical superintendents to individuals who have had long experience in handling the older types of kilns. Criticism of this sort is an accusation against the balanced and co-ordinated development of research and indicates that the tool is more efficient than the operator.

The problems of research in its broadest sense include this problem of operating personnel, for the true significance of modern development is often poorly understood on account of the weakness of this link in the chain. One way in which every one can help, and particularly those who have been instrumental in bringing science into the lime industry, is by aiding the modern kiln to get a square deal in operation. The place for Orsat apparatus and pyrometer is not in the storeroom, but near the kiln stack, and until chemical control is intelligently used throughout a large portion of the industry much good money, that might be saved and available as profits, will continue to go up in smoke and be a loss.

France's Foreign Trade in the First Four Months of 1921

The April figures of the foreign trade of France are as follows:

	First 4 Months		
	1920	1921	Difference
Imports:	Francs	Francs	Francs
Foodstuffs	2,739,651,000	1,598,000,000	—1,141,651,000
Raw materials	5,199,976,000	3,559,000,000	—1,640,976,000
Manufactured goods	2,714,930,000	1,961,000,000	— 753,930,000
Total	10,654,557,000	7,118,000,000	—3,536,557,000
Exports:			
Foodstuffs	474,522,000	700,000,000	+ 225,478,000
Raw materials	1,237,971,000	1,762,000,000	+ 524,029,000
Manufactured goods	2,861,362,000	4,520,000,000	+ 1,658,638,000
Postal parcles	197,041,000	418,000,000	+ 220,959,000
Total	4,770,896,000	7,400,000,000	+ 2,629,104,000

The trade balance is:

First four months 1920: Adverse—5,883,661,000 f.
First four months 1921: Favorable—282,000,000 f.

In connection with the above figures, it is noteworthy that the favorable trade balance of 129,000,000 f. which France accumulated in the first three months of the current year has been increased to 282,000,000 f. in the month of April and that a total adverse trade balance of 5,883,661,000 f. (1920) has been changed into a favorable trade balance of 282,000,000 f. (1921).

Determining Factors for the Life of a Pneumatic Tire*

By William G. Nelson

THERE are five very important and very decisive factors for determining the life of a pneumatic tire. Each has a direct bearing upon the other and a weakness in any one will prove a deathblow to the ultimate mileage which a tire is supposed to give. These five factors are: Rubber and compounding materials, fabric, construction, vulcanization and usage.

Rubber and Compounding Materials Used for Tires

The rubber and compounding materials are comprised of rubber, fillers, softeners, accelerators and vulcanizing agents. A mixture of rubber, surphur and other materials is called a compound. There are various kinds of compounds used in a tire, as tread, carcass friction and skim coat, breaker friction and skim coat, and side wall. The tread must have good wearing qualities, good appearance and co-ordination with the carcass. By this last phrase is meant the ability to adhere properly to the remainder of the tire. Good wearing qualities are obtained by properly compounding suitable materials and curing agents with high-grade wild or plantation rubber. The most finely divided fillers, such as zinc oxide, gas- and lamp-black and similar mineral fillers, are extensively used due to their microscopical fineness, which gives high tensile strength, good stretch and resistance to abrasion, cutting and aging. Friction and skim coat stocks are so compounded as to give good adhesion to the fabric and a cushioning effect between the plies of fabric. These stocks are composed almost entirely of rubber, softeners, sulphur and accelerators. The vulcanizing agent, which is sulphur, and accelerators are, excepting the rubber, the most important parts of a compound. An accelerator is a material which accelerates the chemical combination of the sulphur with the rubber; since their action is so erratic in mixing, calendering and vulcanizing, only experienced men should undertake the handling of these agents. The side wall must have good appearance, as it holds one of the most conspicuous places on the tire. It is used for the protection of the fabric against chafing and moisture. Since it is continually exposed to atmospheric conditions it must have good aging qualities rather than high tensile strength or long stretch.

All compounds that come in contact with another must have good adhesion after vulcanization. The factors that bear upon this condition are: Type of rubbers selected; kind and amount of fillers, sulphur and accelerators; mixing and calendering of the compound; building of the tire, and finally the degree of vulcanization.

Fabric

Fabric is the foundation upon which the tire is built. It is used to give stability and strength. There are two well-known classes of tires: the square-woven fabric and the cord fabric. In the square-woven fabric tire the threads in each ply run in both directions, alternating over and under as in a piece of ordinary cloth. In the cord fabric tire the threads or cords in each ply run parallel with the exception of a few small cross threads, used simply to hold the cords in place while they are being impregnated with the rubber compound. The life of a tire would be greatly increased if internal friction could be eliminated. The internal friction caused by intermittent distortion of the tire in use is the result of the friction of the threads upon one another and the strains and stresses set up in the rubber compound. Naturally the fabric which gives the least amount of internal friction will accordingly give the longest life to the tire. Since square-woven fabric cannot be thoroughly impregnated with rubber compound the places where threads cross will be left bare and at these points flexing will cause a sawing action and the generating of frictional heat.

Influence of Heat on the Life of Tires

It has been demonstrated very clearly by experiment that when the temperature resulting from mechanical action reaches 230 deg. F. vulcanized rubber ceases to function as an adhesive compound, crumbles into minute particles which fail to resume their original condition, causing the compound to lose its function in the tire. This causes separation, weakness, and finally a blow out.

It may be interesting to know that 265 deg. F. is not an uncommon temperature reached in a tire when driven at high speed over the road; this is particularly true of large truck tires. In the case of cord fabric each thread is imbedded in the rubber compound and the internal friction is reduced to a minimum. The ideal condition would be to have each cotton fiber of the thread imbedded in rubber, but of course this is not practical and on account of weaving difficulties has not been accomplished.

Cord vs. Square-Woven Fabric

Since cord fabric comes closer to the ideal condition, the time is not far distant when it will entirely supplant square-woven fabric in the carcass of the tire. A step in this direction will be made when the cost of producing cord tires is sufficiently reduced to successfully compete with the square-woven tire. A brief summary of the advantages derived from the use of cord tires would include easier riding, due to greater resiliency; saving of gasoline and oil; saving of machinery, and more miles per dollar.

Fabric is also used in the breaker and chafing strips. The breaker fabric is covered with a rubber compound that will act as a binder between the soft-cushion stock and the stiff-tread stock. The breaker fabric is used to give stability to this compound and therefore to decrease the separation between the tread compound and the cushion. The chafing strips are used for protection and reinforcement.

Mixing and Calendering

At this point something should be said about the mixing of the rubber and ingredients, and the calendering or application of the compound to the fabric. There are so many factors that enter into the mixing that they can be only briefly described here. Breaking down of the rubber by mechanical action changes it from a tough, hard state to a tacky, plastic condition. This influences the impregnation of the fabric, tackiness, blooming and other physical qualities, and also the vulcanization. The thoroughness of incorporation of the compounding elements has an influence upon uniform vulcanization and wearing conditions. In

*Read before the American Institute of Chemical Engineers, Detroit, June 23, 1921.

order to eliminate to the highest degree the variable conditions inherent to milling, calendering, building operations and vulcanizing it is necessary to have every process standardized and a rigid inspection to hold to a minimum the factor of the human element. Therefore all reputable manufacturers analyze thoroughly all compounding materials and rigidly inspect all fabric before these elements enter into the tire and also carefully control the degree of vulcanization in the finished product.

Tire Construction

Tire construction is an art in itself. It is like the building of a machine and just as much care must be used in designing a tire as is used in designing a finely adjusted machine. As nearly every tire is built on an iron core and is vulcanized in a mold the space occupied by the tire is constant and is filled with a unit composed of many variables. Therefore when the fabric is frictioned and skim coated it is held to a gage of a maximum or minimum variation of 0.002 or 0.003 in. Likewise all other parts as top cushion, breaker, tread, bead and side wall are held to a maximum or minimum gage. The proportion of the fabric to the rubber compound must be properly balanced. The addition of an extra ply or the increase of the thickness of rubber compound may destroy this balance and materially weaken instead of strengthen the tire. It has been demonstrated many times by actual service tests that the correct distribution of rubber compound in the tire will increase its life several thousand miles; or the changing of the sulphur one-half of one per cent in a single compound will cause an equal variation in the mileage. There are many faults in a finished tire that can be attributed to improper construction, as excessive overflow, wrinkling of breaker and plies, incompletely filled molds, and weakness in the beads. These are usually remedied by changing the construction but in some instances the proper results can be obtained by changing the compound, the process of vulcanizing, or redesigning the equipment.

Vulcanization

There is probably no phase of tire manufacture that receives more attention than the vulcanization of the tire, and still there is no phase that is more problematical. The proper degree of vulcanization is an empirical condition existing in the various components of a tire which is determined by results obtained by road tests. Either an under-vulcanized or an over-vulcanized tire will give low mileage; even if a single part, such as cushion, breaker or tread compound, is over- or under-vulcanized, the entire tire will give poor results.

The controlling factors in a compound to obtain this empirical state are the sulphur, accelerators, rubbers, milling and calendering, time and temperature of the cure. Any one of these conditions will materially affect the state of vulcanization. The proper manipulation of these variables is a chemist's job and requires great care, thought and experience. It is absolutely essential for the chemist to have a laboratory fully equipped to make comparative physical and chemical analyses, to develop new compounds and try out new compounding ingredients. Various types of rubbers made by different methods of coagulating, washing and drying have different vulcanizing ranges and optimum cures—that is, the state of maximum efficiency when vulcanized—therefore great care must be exercised in their selection for a compound.

Furthermore the optimum cures of all compounds must be so adjusted that in the finished product every component of the tire has simultaneously reached its maximum efficiency. Excessive milling causes the compound to vulcanize more slowly but more uniformly; decreases the tensile strength, and increases the stretch. These actions can be explained by the breaking down of the rubber molecule into its polymeric stages, each stage having its own particular range and optimum cure with its corresponding tensile and stretch. The slower a compound is vulcanized to its optimum cure the better resistance to aging it will have; therefore low vulcanizing temperature and long time is preferable for quality of product, but owing to the demands of quantity production higher temperatures and shorter times are resorted to. The scientific explanation of the effect of time, temperature and mechanical action upon quality of product is a problem of research and it is high time that some of these problems were given proper investigation by the scientific men of today.

Usage

If the tire is neglected and abused while in service, all the care used in testing and selecting the rubbers and the compounding materials, analyzing the fabrics, standardizing the operations and maintaining an experienced organization in order to make the most uniform and perfect product will be of no avail. A pneumatic tire is designed and built to contain air or an inert gas under pressure, and there are no recommendable substitutes for it on the market today. The greatest danger that befalls a tire in service is under-inflation. Proper inflation is to the life of a pneumatic tire what proper food is to the life of a living being.

Causes for Premature Failures of Tires

Eighty per cent of the failures in tires can be traced to under-inflation. Briefly the results of under-inflation are early separation in all parts of the tire, rim cutting, abnormal development of frictional heat, greater power and fuel consumption, rupturing of the fabric, splitting of tread and abnormal strain throughout the tire. The Society of Automotive Engineers, the Tire and Rim Association and all the large manufacturers of tires have agreed upon standard pressures to be used in tires and these pressures should be adhered to religiously in order to obtain the highest mileage. Overloading is another abuse that is often imposed upon a tire which causes an early breakdown of the carcass and finally a blow out. Other causes for premature failures are: Improperly fitting rims, which cause rim cutting, thus exposing the fabric to moisture and chafing; misalignment of wheels, which causes excessive tread abrasion; running over curbs, deep ruts, stones, nails and glass, which causes breaks and cuts in the tread and carcass; sudden braking, which causes tread abrasion and separation; turning corners at high speed, which causes excessive strains on the fabric and later a rupture; overheating, which causes separation, and sun exposure, which causes checking.

The ultimate desire of every motorist is to obtain the most miles per dollar per tire with the advantages of riding on a cushion of air, and the only way for him to obtain his desire and retain these advantages is to use common sense in the use and care of the pneumatic tire.

Artificial Seasoning of Steels

Review of Available Data on Length Changes and Spontaneous Generation of Heat in Hardened Steels, Together With Results of Preliminary Experiments on Artificial Seasoning by Different Methods of Several Types of Steels Used for Making Limit Gages

BY H. J. FRENCH, MET. E.

THE fact that steels, under certain conditions of work and thermal treatments, undergo changes with time at ordinary atmospheric temperatures has long been known or suspected, and it has also been definitely established that these changes can be hastened by suitable heat-treatment or other artificial seasoning methods. Very little is known, however, regarding the nature of such changes, and there are relatively few publications available which deal with this question.

So-called tempering of hardened steels in hot water (aging) has long been used. While the discovery of the fact that hardening is effected by quenching from 100 deg. C. is credited to Langley and Metcalf[1] (1892), Hetzel[2] calls attention to earlier experimental work carried out along similar lines by H. Carron in 1872-73.

Schottky[3] has noted spontaneous generation of heat in hardened carbon steels when tempered at 100 deg. C., the magnitude of this effect apparently depending upon the carbon content and quenching temperature as well as on other factors.

BRUSH'S WORK ON HEAT GENERATION

Brush[4] has also shown that high-carbon tool-steel and chromium-tungsten "high-speed" steel spontaneously generate heat in appreciable quantity for at least several weeks after water-quenching from a high temperature and that the rate of generation steadily diminishes with time. Samples of hardened carbon tool-steel likewise shrank progressively when tempered to "straw color," to "light blue" and finally annealed, while after hardening, certain samples gave evidence of spontaneous shrinkage for many days in measurable amount. The behavior of these latter specimens was similar to that of the former in the gradual decrease in magnitude of the observed effect, which suggested a relationship between the two phenomena. Contraction was not considered the prime cause of the spontaneous heat generation, because calculations showed it to be inadequate in amount.

In more recent experiments carried out by Brush and Hadfield[5] specimens of a nickel-chromium steel behaved similarly when quenched from a temperature just above that of decalescence. The magnitude of the observed heat-effect was increased by a repeated treatment and persisted even when the specimen was heated for a third time and allowed to cool very slowly to a temperature where complete recovery of magnetic susceptibility was attained before quenching. Because of this anomaly further investigation by Brush, Hadfield and Main[6] was undertaken and some interesting facts were brought to light.

Attention is called to the fact that absorption of heat resulted from quenchings made at rising temperatures which generally had not previously been exceeded and that carbon tool-steel showed none of the eccentricities of the nickel-chromium steel when quenched below the hardening temperature; but when quenched above they behaved very much alike. It was also found that the rate of contraction of quenched steels followed the same law as the rate of evolution or absorption of heat which, after a short initial period, is approximately in inverse ratio to the time after quenching. It is generally considered that such contraction is due, at least in good part, to completion of the partly suppressed allotropic transformation.

JAPANESE STUDIES ON AGING

Matsushita[7] has studied the nature of the slow contraction of hardened Krupp carbon steels and concludes that in well-hardened samples there is always a gradual contraction, whereas in imperfectly hardened steels there is a gradual elongation or an elongation associated with a subsequent contraction. It is stated that elongation results from the imperfect A_1 transformation, while contraction is ascribed to the separation of an unstable cementite from its solid solution (martensite) which does not affect the hardness. Complete separation of the first unstable carbide at room temperature requires several months or longer, while the same separation follows within two hours by heating the steel to 100 deg. C. The author also reports that the elongation or contraction of hardened steel is always accompanied by heat evolution.

Low elongation and reduction of area values have been noted by Reinhardt and Cutler[8] in tensile tests made immediately after heat-treatment and machining of test-bars taken from 5¾-in. square steel billets containing 0.49 to 0.55 per cent carbon. Aging at room temperatures for twelve to twenty-four hours sometimes increased ductility more than 100 per cent, whereas similar beneficial effects were obtained in very much shorter time by heating to 120 deg. C. (248 deg. F.). Evidence is presented that complete restoration of

Published by permission of the Director, Bureau of Standards.

*Physicist, Metallurgical Division, National Bureau of Standards, Washington, D. C.

[1]Discussion of paper by A. M'Cance, "A Contribution to the Theory of Hardening," *J. I. & S. Inst.*, 1914. No. 1, p. 250.

[2]E. Hetzel, "Tempering in Hot Water," *Rev. Metal.*, vol. 12 (1915), p. 584.

[3]H. Schottky, "On a Thermometrically Recognizable Tempering of Quenched Steel at 100 deg. C.," *Ferrum*, vol. 10 (1912), p. 274.

[4]C. F. Brush, "Spontaneous Generation of Heat in Recently Hardended Steel," *Proc. Am. Phil, Soc.*, vol. 54 (1915), p. 154.

[5]C. F. Brush and Sir R. A. Hadfield, "Spontaneous Generation of Heat in Recently Hardened Steel," *Proc. Roy. Soc.* (London), vol. 93A (1917), p. 188.

[6]C. F. Brush, Sir R. A. Hadfield and S. A. Main, "Further Experiments on Spontaneous Generation of Heat in Recently Hardened Steel," *Proc. Roy. Soc.* (London) (abstract), vol. 95 (1918), p. 120.

[7]T. Matsushita, "On the Slow Contraction of Hardened Carbon Steels" (abstract), *Proc. Tokyo Math.-Phys. Soc.*, vol. 9 (1917-18), p. 312.

[8]G. A. Reinhardt and H. L. Cutler, "Effect of Time and Low Temperature on Physical Properties of Medium-Carbon Steel," *Bull.* A.I.M.E., vol. 151 (1919), p. 1091.

ductility, which required about sixteen days at room temperatures, could be obtained at 120 deg. C. in twenty-five hours.

Honda and S. Saito[9] have recently studied the effects of two artificial seasoning treatments on the properties of K. S. magnet steel of the following composition:

	Per Cent
Carbon	0.40— 0.80
Cobalt	30.0 —40.0
Tungsten	5.0 — 9.0
Chromium	1.5 — 3.0

Residual magnetism was not appreciably diminished by prolonged heating for 10-hour intervals at 100 deg. C. (212 deg. F.), while mechanical aging, carried out by dropping a bar 850 times on a concrete floor from a height of 1 m., decreased the magnetization by 6 per cent of its initial value.

Nature of Spontaneous Changes

Undoubtedly the spontaneous evolution of heat, dimensional changes and other observed effects such as have been described above are directly associated with the initial stresses and suppression of the transformations resulting from rapid cooling (quenching). As recently pointed out by Jeffries,[10] the presentation of an adequate explanation of such phenomena offers extraordinary difficulties. Admittedly an atomic rearrangement takes place in hardened steels at room temperature and because of the resistance of mechanical cohesion the time factor is pronounced.

If the character of the dimensional changes (contraction or elongation) occurring in quenched steels is dependent upon the adequacy of hardening as reported by Matsushita,[7] it would appear that for each steel there would be a critical time-temperature relationship in quenching which would at least decrease the magnitude of such changes, and investigation of this point might well be undertaken.

Stability of Gages

Dimensional changes with time are often encountered in hardened reference gages, and their magnitude and occurrence have been found to vary considerably in gages produced from the same materials under similar conditions of manufacture. In this case, where the steel is used as a standard of measurement, changes in length and planeness of the order of 0.00005 in., which ordinarily might be neglected, become of considerable importance, as do also the methods capable of hastening their completion.

During 1919, at the request of the Ordnance Department, U. S. A., a systematic investigation of the effects of seasoning of gage blocks was planned, using five steels already employed in the manufacture of gages or those which appeared to offer possibilities for such work. A large number of gages were produced and seasoned in various ways, following which changes in dimensions were noted over an extended period. While it is not possible to draw any definite general conclusions from the results obtained, it is believed that presentation of the following data will be of interest and possibly benefit those who may at some future time elect to investigate this subject, or perhaps it will bring to light existing information not yet published.

[9]K. Honda and S. Saito, "On K. S. Magnet Steel," *Proc. Phys.-Math. Soc. Japan*, 3d series, vol. 2, No. 3, p. 32.

[10]Zay Jeffries, "Physical Changes in Iron and Steel Below the Thermal Critical Range," *Mining Met.* (Feb. 1920), vol. 158, section 20.

All gages used were prepared in the gage section of the Bureau of Standards, while the actual work in carrying out the various heat-treatments was performed by H. R. Yerger, formerly of the staff, who also planned the investigation in consultation with various members of the metallurgical division, gage section and optics division. C. G. Peters and assistants of the interferometry section of the last named division of the Bureau have carried out all the measurements for flatness and length of the gages as reported in this paper.

Materials and Procedure

Five steels were chosen for the work on permanence as shown in Table I. They were received in the form of 1-in. hot-rolled rounds and were first annealed and then examined microscopically for excessive non-metallic inclusions and surface decarburization. As a result of this examination a few bars were discarded, while the remainder were machined and ground into rough gages. These latter were then hardened by heating in a lead bath (equipped with suitable pyrometric control) and quenched in oil. After grinding, the blocks were seasoned in various ways and the gages were then finished in accordance with the Hoke method.[11]

The hardening treatments used for the five steels are shown in Table II. Temperatures chosen are not very different from those ranges recommended by the manufacturers, though in one case preliminary quenching experiments were also carried out to determine what would be a suitable treatment. In selecting the various seasoning treatments listed in Table III, time and temperature variations as well as relatively rapid changes between temperatures above and below that of the room

[11]H. L. VanKeuren, "Manufacture of Hoke Precision Gages at the Bureau of Standards," *Am. Mach.*, April 3, 1919, p. 625.

TABLE I. COMPOSITION OF STEELS TESTED

Code Letters	Chemical Composition, per Cent									Suggested for Investigation Because of
	C	Mn	P	S	Si	Cr	Ni	W	V	
HC	0.96	0.35	0.014	0.017	0.25	1.31	0	....	..	Use for bearings requiring high hardness, permanence, wear resistance, etc.
K	0.87	1.10	0.017	0.10	0.23	0.46	0	0.43	0.12	Avoidance of cracking and warping in hardening.
DR	1.18	0.20	0.016	0.013	0.21	0.08	0	....	....	High hardness obtainable in heat - treatment.
ST	0.29	0.36	0.009	0.014	0.70	13.20	0	....	....	Non-corrodible qualities.
DB	1.18	2.20	0.008	0.026	0.26	18.10	0	....	....	Non - deforming qualities and high cutting value.

TABLE II. HARDENING OF THE STEELS TESTED

Code Letters	Oil Quenched from Deg. C.	Deg. F.	Remarks
HC	850	1,562	
K	800	1,472	Note.—Temperatures approximating those recommended by the manufacturer have been used.
DR	800	1,472	
ST	955	1,751	
DB	955	1,751	

TABLE III. SEASONING TREATMENTS USED

Code Letter	Description of Treatment
A	No treatment after hardening.
B	Heated in oil 3 hr. at 100° C. (212° F.) and air-cooled.
C	Heated in oil 3 hr. at 150° C. (302° F.) and air-cooled.
D	Heated in oil 3 hr. at 200° C. (392° F.) and air-cooled.
E	10 alternate 5-minute dips in oil at 200° C. (392° F.), and water at 0 to −5° C. (32 to 23° F.)
F	80 alternate dips as for E above.
G	44 alternate dips of 3 minutes in gasoline at 35 to 20° C. (—31 to —4° F.) and 7 minutes in oil at 200° C. (392° F.).
H	Heated in oil 1 hr. at 275° C. (527° F.).
I	Heated in oil 4 hr. at 275° C. (527° F.).

were considered important. The latter class of treatments may or may not involve a change in state depending upon the hardening conditions, whereas the former is considered to decrease the resistance of mechanical cohesion.

In making tests for planeness (flatness), the usual opticians' method of testing plane surfaces was used. Length tests were made by comparing the gages with the standard precision gages at the Bureau of Standards. The standard and unknown gage were brought into close contact with a plane glass surface and the difference in length was determined from the displacement of the interference fringes occurring when a second glass plane was made to form wedge-shaped films of air over the upper surfaces of the gages, and the film illuminated by monochromatic light at nearly perpendicular incidence. This method for testing gages is described by Peters and Boyd.[12]

Importance of Early Observations

A summary of the results of these measurements over an extended period, together with records of Shore scleroscope hardness and intervals between date of hardening, first and last measurements, is given in Tables IV and V for each of the five steels under consideration. It would have been desirable to have the first measurement made on each gage on the day of seasoning, which in turn might have been carried out after a definite number of days from the day of hardening. However, this was not found possible on account of the number of operations and length of time required in finishing the blocks and because of the large number of measurements for length and planeness which would of necessity have to be made on any given day. A schedule approximating this procedure as closely as possible was therefore adhered to. Though others are perhaps not in agreement with this, the writer is of the opinion that under these conditions a very important period for studying permanence (the time immediately following the hardening and finishing of the gages) has, by force of circumstances, been neglected, assuming that the changes in any given short time interval (a few days

[12] C. G. Peters and H. S. Boyd, "The Calibration and Dimensional Changes of Precision Gage Blocks," *Am. Mach.*, Sept. 30 and Oct. 7, 1920.

TABLE V. PLANENESS CHANGES IN ½ INCH GAGES IN MILLIONTHS OF AN INCH

Steel	First Meas., No. of Days After Hardening	No. of Days Between First and Last Measurements	Ave. of 4 Gages	Max. of 4 Gages	Min. of 4 Gages
K	14	211	7	17	0
	8	227	29	58	5
	8	227	5	23	0
DR	8	227	13	69	0
	8	227	6	23	0
	8	227	8	34	0

TABLE IV. SUMMARY OF DIMENSIONAL CHANGES IN QUENCHED 2-IN. REFERENCE GAGES WITH AND WITHOUT SEASONING TREATMENTS AND SHORE HARDNESS VALUES

Each seasoning treatment was applied to 4 gages. Where no changes in length or planeness occurred equal to or greater than 0.00001 in., no figures are given.

				—Seasoning Length Changes in Millionths of an Inch*—						
								Shore Hardness of Seasoned Gages		
Steel	Annealing	Hardening Heated in Lead Bath to	Treatment	No. of Days After Hardening	No. of Days Between First and Last Measurements	Average of 4 Gages	Max. of 4 Gages	Min. of 4 Gages	Average of 4 Gages	Max. of 4 Gages	Min. of 4 Gages
HC	900° C. air-cooled then 800°C. furnace cooled	850° C. and oil quenched	A	..	...	.....	.....	.....	93	95	92
			B	2	217	70	80	50	96	98	94
			C	2	217	17	20	10	92	95	89
			D	2	217	10	20	0	84	87	81
			E	2	217	7	20	0	90	92	84
			F	..	...	.....	.....	.....	89	94	82
			G	13	245	—7	—20	0	86	90	80
			H	..	...	.....	.....	.....	86	88	85
			I	..	...	.....	.....	.....	84	85	81
K	830° C. air-cooled then 800°C. furnace cooled	800° C. and oil quenched	A	12	212	—140	180	0	85	88	83
			B	12	212	—2	—10	0	89	90	88
			C	..	...	.....	.....	.....	88	91	83
			D	..	...	.....	.....	.....	85	88	83
			E	..	...	.....	.....	.....	87	88	85
			F	..	...	.....	.....	.....	85	86	83
			G	14	216	—2	—10	0	78	85	75
			H	..	...	.....	.....	.....	84	88	80
			I	..	...	.....	.....	.....	86	87	85
ST	900° C. air-cooled then 800°C. furnace cooled	955° C. and oil quenched	A	16	212	5	10	—10	66	67	65
			B	16	212	17	30	—10	72	75	69
			C	16	212	12	20	0	68	69	67
			D	16	212	7	30	0	68	72	65
			E	..	...	.....	.....	.....	70	73	68
			F	16	212	2	10	0	71	75	67
			G	13	220	10	20	0	64	68	60
			H	13	220	5	20	0	68	70	65
			I	13	220	12	30	0	65	70	60
DR	800° C. air-cooled, then 770°C. furnace cooled	800° C. and oil quenched	A	12	229	5	20	0	73	75	72
			B	12	229	5	20	0	78	85	70
			C	12	229	12	20	0	79	88	75
			D	12	229	5	20	0	79	85	73
			E	..	...	.....	.....	.....	75	78	72
			F	..	...	.....	.....	.....	80	83	76
			G	14	219	25	40	20	68	72	63
			H	14	219	22	30	20	71	72	70
			I	14	219	20	20	20	71	72	70
DB	900° C. air-cooled, then 880° C. furnace cooled	955° C. and oil quenched	A		(See note below)		.....	.....	66	70	60
			B	..	...	.....	.....	.....	70	75	65
			C	..	...	.....	.....	.....	84	88	80
			D	..	...	.....	.....	.....	66	71	60
			E	..	...	.....	.....	.....	75	85	65
			F	..	...	.....	.....	.....	81	87	75
			G	..	...	.....	.....	.....	70	75	65
			H	..	...	.....	.....	.....	68	70	66
			I	..	...	.....	.....	.....	73	75	70

* Negative signs before length changes refer to decrease; all other figures to an increase.

NOTE.—The 2-in. gages DB3 and DB4, subjected to treatment A, which showed no change in surface up to the time of the fifth measurements, became so badly deformed thereafter that no further measurements could be made, as detailed in the text. Attention is drawn to the fact that blocks of steel ST, DB and DR are in general considerably softer than those usually employed in production of gages. Blocks of steel HC and K are nearer the low limit of hardness generally used.

or weeks) are within the limits of experimental error of measurement. That this assumption may be in error is indicated by the behavior of gages DB3 and DB4, which received no artificial seasoning treatments (treatment A Steel DB of Table IV). These gages, which up to the time of their fifth measurements had shown no change in surface, became so badly deformed during the period between their fifth and sixth measurements that they could not be made to adhere to the glass plate at the later date. It was found that the surfaces had become cup-shaped, the inner half being fairly plane, but sloping irregularly upward to the edges, the depth of the cup-shaped figure being from 0.0001 to 0.0002 in. for DB4 and from 0.0002 to 0.0005 in. for DB3.

The work of earlier investigators as briefly discussed in the introduction further supports the writer's contention that early changes are more rapid than those occurring at a later date.

Conclusions

Based on total change from first to last measurements, the following conclusions may be drawn:

(*a*) The short gages (½ in.) showed no appreciable changes in length with or without artificial seasoning over a period of approximately seven months (first measurement one to two weeks after hardening). No appreciable changes in planeness occurred in the long gages (2 in.) with the exception of the two unseasoned blocks DB3 and DB4 mentioned above.

(*b*) Longer gages than those used (2 in.) would be more desirable for studying length changes with time, because of the extremely small variations actually occurring. About 6 to 8 in. is recommended.

(*c*) Variation in behavior of duplicate gages is confirmed by the K steel blocks subjected to no artificial seasoning treatment. One of these blocks showed no dimensional changes in 217 days between first and last measurements, while a duplicate decreased 0.00018 in. in the same period. Likewise duplicate artificially seasoned gages show differences as illustrated by steel ST, treatment D, Table IV.

(*d*) Except in the case of the plain carbon steel (DR) the changes in planeness are not appreciable.

(*e*) Gages produced from steels ST, DR and DB are softer than reference blocks ordinarily used. The latter are kept between about 90 to 100 Shore hardness. From this standopint, steel ST is unsatisfactory, as it is not possible with ordinary treatment to maintain the hardness within the limits described. A higher-carbon alloy of this type would be more desirable, with possibly a decrease in chromium content so as not to impair its stain resistance and at the same time reduce production costs.

(*f*) The plain-carbon steel DR (containing 1.18 per cent carbon) appears to be the least desirable from the standpoint of permanence, showing in the main the greatest changes in length and planeness during a period approximating seven months from first to last measurements. Probably the most desirable are steels HC and K subjected to definite seasoning treatments, the former being the steel generally used in production of reference gages at the Bureau of Standards and closely agreeing with the composition of Johanssen blocks.

(*g*) None of the seasoning treatments applied has been effective in preventing dimensional changes (within the limits of measurement) in all five steels. Also all seasoning treatments applied appear to effect permanence in Steel DB (containing 1.18 per cent C, 2.20 per cent Mn and 18.10 per cent Cr). Treatments H and I, however, have decreased the hardness.

Recommended Heat-Treatment

(*h*) Seasoning treatments E and F, consisting respectively of ten and eighty alternate 5-minute dips in oil at 200 deg. C. (392 deg. F.) and ice water at 0 to —5 deg. C. (32 to 23 deg. F.) are the most generally effective treatments tried for obtaining permanence. Probably less than eighty would in many instances suffice to bring the steel in a state of rest under conditions of treatment and manufacture as previously outlined.

Measurements made at intervals of approximately one and two weeks, one, two, four and seven months after initial readings of length and planeness do not give very much information regarding the progress of the changes taking place. Unsuitable steels exhibiting the greatest instability in either length or planeness appear to increase progressively in error with time. In many cases of more suitable steels possessing great constancy these changes seem to occur in the intervals immediately following the first measurement, the gages thereafter remaining constant. However, no very definite statements may be made in this respect.

Shrinkage in Steel

In a majority of the blocks examined showing dimensional changes there is an elongation, but in the case of steel K shrinkage only is observed. This is unusual, as the changes observed in hardened blocks are usually of the latter type—i.e., decrease in length. Four unseasoned gages produced from this latter material (containing 0.87 per cent C, 1.10 per cent Mn, 0.46 per cent Cr, 0.43 per cent W, 0.12 per cent V) will illustrate progressive shrinkage in hardened steel over an extended period. (Table VI.)

TABLE VI. PROGRESSIVE SHRINKAGE IN RECENTLY HARDENED STEEL

Chemical composition, per cent, C, 0.87; Mn, 1.10; Cr, 0.46; W, 0.43; V, 0.12.

Sample No.	Date of Measurement	Length in Inches	Shrinkage in Inches
K17	Sept. 8, 1919	1.89995	.....
	Sept. 25, 1919		0.00004
	Oct. 24, 1919		0.00007
	Dec. 26, 1919		0.00012
	April 7, 1920		0.00018
K18	Sept. 8, 1919	1.89996	.....
	Sept. 25, 1919		0.00002
	Oct. 24, 1919		0.00003
	Dec. 26, 1919		0.00006
	April 7, 1920		0.00008
K19	Sept. 8, 1919	1.89995	.....
	Sept. 25, 1919		0.00003
	Oct. 24, 1919		0.00005
	Dec. 26, 1919		0.00008
	April 7, 1920		0.00014
K20	Sept. 8, 1919	1.89996	.....
	Sept. 25, 1919		0.00004
	Oct. 24, 1919		0.00006
	Dec. 26, 1919		0.00011
	April 7, 1920		0.00016

No satisfactory explanation for such difference in behavior can be given at this time, but it is of interest to note that microscopic examination indicates more complete hardening of the K steel blocks (martensite-troostite throughout) than is obtained by oil-quenching the carbon-steel gages (DR) which show a less uniform structure consisting of troostite and sorbite at the surface and sorbite in the interior, indicating but local and partial suppression of the transformations and less complete hardening. In view of this fact the work of Matsushita[7] and his conclusions that the type of dimensional change (elongation or shrinkage) is related to the character of hardening becomes of particular interest.

Legal Notes

By Wellington Gustin

Churchward Patents Held Not Invention—Prior Art and History of Vanadium Alloys

In holding the Churchward patents, 845,756, claim 1, and 868,327, claims 1 and 3, each for an alloy of steel, void for want of invention, the United States Circuit Court of Appeals, Third Circuit, discussed the history and growth of the metallurgical art in alloy steel. (Bethlehem Steel Co. vs. Churchward International Steel Co., 268 Federal, 361.) James Churchward, the inventor, secured the patents in 1907 and assigned them to the Churchward International Steel Co., wherein the Carnegie Steel Co. intervened. The U. S. District Court sustained the claims in the patents and found them to be infringed, whereupon the Bethlehem Steel Co. appealed. The Court of Appeals reversed the District Court.

It was said that in the manufacture of steel from alloys in countless combinations and proportions it became known that small quantities of alloying metals and small differences in their proportions frequently make considerable difference in the properties of the resultant steel. Investigation of the metal vanadium, discovered in 1830 in a specimen of iron obtained from ores at Taberg, Sweden, was continued with its widening production from the slags of the Taberg blast furnaces and from mines later found in Scotland and Mexico.

Introduction of Vanadium in an Alloy

Since about 1890 to 1900, when alloy steels became established, the use of vanadium as an alloying metal has grown apace with the discovery and development of its properties. It was discovered that vanadium lay between carbon and chromium in the properties it impresses upon steel and that small amounts, ranging from 0.10 per cent to 0.50 per cent, increase substantially the tenacity, elastic limit, tensile strength and the fatigue resistance of the metal, and also its malleability and hardness after tempering. Hence its adaptability in alloy steels where, as in armor plates, especially hard surfaces are required, and where, as in automobile and locomotive parts, shock and vibration are constant and metal fatigue inevitable.

So the use of vanadium as an alloying ingredient in alloy steel increased in the metallurgical art as these properties were revealed. Before vanadium thus came into use the art contained a variety of alloy steels named and known by the essential ingredients composing them. Aside from carbon and manganese steels, whose controlling ingredients were present by nature, or when desired were increased by additions, the patent records and the literature of the art showed nickel steels, chrome steels, nickel-chrome and chrome-nickel steels, whose characteristics were those inherent in their dominant alloying materials. Later vanadium was added to these, and in consequence there came into the art vanadium-carbon steels, vanadium-nickel steels, chrome-vanadium steels, "whose distinctive characteristics reflected the dominance of their alloying elements."

This was the state of the art, as was said, when Churchward entered it with his two patents. It was claimed that these inventions showed for the first time, in addition to the natural alloying elements of carbon and manganese, the three added elements of nickel, chromium and vanadium, thus establishing, as it was contended, the first vanadium-nickel-chrome alloy steel.

Both of the patents in suit relate to alloy steels as distinguished from carbon steels or normal steels. Both claim an alloy containing, in different proportions, the same alloying metals of steel (with varying carbon content), nickel, chromium, manganese and vanadium. In neither patent is it clear whether the invention disclosed is in the alloying metals or in their proportions or in both. So also in neither is it claimed that the resultant product contains or has in higher development the properties known to characterize the constituent alloying ingredients either separately or in combination.

The only new property, says the court, claimed for the alloy of the patent is found in the following language:

"It is believed that the alloying elements named react on each other to produce chemical and molecular changes of such a nature that the tungsten, chromium and manganese are permitted to harden the steel, while the *vanadium removes or prevents brittleness and imparts toughness without softening the alloy.* . . . In cases where the product is to have extreme toughness and hardness the tungsten may be omitted"—as it is from the claim in suit.

The specification of the second patent differs little from the first. The same theory of chemical reaction and molecular change described in the first patent is repeated in the second, differing from the first only in addition of nickel to the element of vanadium in effecting removal or prevention of brittleness without softening the alloy. On comparison it is seen that the alloying metals are the same in both patents, the proportions of those in the second patent covering the proportions of those in the first. The proportion of each ingredient in each patent begins at the same minimum, and in the second patent the proportion of each ingredient comes up to that of the first patent and passes on to a higher maximum, producing, as the only difference, as the court saw, a range wider in the second than in the first, without any claimed difference in results, properties or performance of the two alloys.

While the patents are *prima facie* evidence that the alloys constitute invention, still such is open to attack should they lack new and advantageous properties over the prior art, said the court. And so the defendant atacked the *prima facie* case.

Court's Dictum on Patentable Novelty

The court said patentable novelty may reside either in the elements of alloys or in the proportion of the elements. If novelty of elements is claimed on the first patent, that patent falls when it is proved that before Churchward vanadium was used with chromium, nickel, manganese and carbon in alloy steels. If novelty of elements is claimed in the second, that patent likewise falls as the first. Therefore novelty in the invention must be found in the proportion of the elements. On this issue the defendant showed that in endeavoring to determine experimentally the value of vanadium in nickel-chrome-manganese steel alloys it had used the elements of the patent alloys in substantially the same

proportions specified by the patents before Churchward's alleged inventions. However, the court said this was not taken as conclusive of anticipation, for it was possible that the defendant, in employing the same elements in the same proportions, may not, because of difference in heat-treatment, have obtained the alloys of the patents. (Pittsburg Steel & Iron Co. vs. Seaman-Sheeth Co., 248 Fed., 705.)

But novelty of proportions in the sense of the patent law involves something more than figuring out proportions differing from any that were known before. It involves new results from new proportions, developing a new metal, or, it may be, an old metal with new characteristics of structure or performance, embracing entirely new, or at least substantially enhanced, qualities of utility. (Miami Copper Co. vs. Minerals Separation, Ltd., 244 Fed., 752.) To prove that the alloys of the patents in the proportions specified lack patentable novelty the defendant produced evidence, which in the absence of contradiction, the court said, must be accepted as conclusive.

Defendant's Evidence Uncontradicted

On the issue whether the alloys of the patent contain advantageous properties over alloys of the prior art made from the same elements in different proportions, or whether they contain properties different from those of the prior art, the defendant offered evidence to prove that while vanadium has a beneficial effect in carbon steels, in nickel steels and particularly in chrome steels, it has no such effect in chrome-nickel steels; that instead of producing the only new and useful property in the resultant steel claimed for it in the two patents—the removal and prevention of brittleness—vanadium increases brittleness, that it (Bethlehem Steel Co.), after using vanadium in nickel-chrome-manganese alloys within the range of the proportions of the patents, found that vanadium introduced a detrimental condition in the product and in consequence abandoned its use; that Carnegie Steel Co. (though under license of the patents and free to continue) found it troublesome to get out tonnage when adding vanadium to a nickel-chrome-manganese alloy and likewise abandoned its use; and that Midvale Steel Co. after experiments was not sufficiently encouraged to begin its use.

The plaintiff controverted none of this evidence, and the defendant's evidence was taken as truth. Neither did the plaintiff produce evidence that the alloys of the patent were novel or that they contained new elements of utility, in that they were different from or better than prior nickel-chrome-manganese-vanadium alloys either in metallurgical or physical characteristics or in performance. It rested first on the presumption of utility of the alloys arising from the fact that defendant had made such alloys. While this is valid evidence, it alone does not prove in the light of the case that the utility of the patented alloys was greater than or different from that of kindred alloys made before the patents. Vanadium was an alloying metal of the prior art and free to be used by anyone desiring to use it.

To constitute invention in the continued use of vanadium it must appear, said the court, that some new property had thereby been attained or some newly useful result had been achieved.

Again the patent owners relied on proof that Carnegie Steel Co. had paid it the substantial sum of $275,000 in settlement of infringement litigation and for licenses under the patents. But the court said that unless it were to substitute the opinion of the experts in metallurgical knowledge of the Carnegie Steel Co. for its own judgment, without knowing what evidence was before them but well knowing the evidence before it was not before the Carnegie experts, it must resolve the issues as the case has been made by the evidence. And this was done by finding that the evidence was against invention.

Chemical Company Obtains Reversal of Decree Under Workmen's Compensation Act in Maine

In a compensation case the Supreme Judicial Court of Maine has said that the Industrial Accident Commission, while primarily a judicial body, exercises certain judicial functions and in the exercise of these functions it acts judicially, and, while it determines finally the trustworthiness and weight of testimony, its findings must be based on evidence.

Further, it is said the findings of fact under the workmen's compensation act by the Industrial Commission cannot be disturbed by the courts in the absence of fraud, but such findings must be grounded upon evidence presented under such circumstances as to afford full opportunity for comment, explanation and refutation. (113 Atlantic, 28.)

The case involved proceedings by M. Gauthier under the act to obtain compensation for the loss of a leg in the employ of the Penobscot Chemical Fiber Co. There was an award of compensation and the chemical company appealed, resulting in the Supreme Court reversing the decree.

The Maine statute, chap. 50, sec. 21, authorizes certain medical testimony to be taken ex parte, but, says the court, such is not to be made the foundation of a decree until it is produced in evidence, so that either party may have an opportunity to explain or contradict it.

Wages in German Metal Industry

The Union of German Metal Workers is the largest trade-union in Germany and includes more than 1,600,000 members. This union has a statistical bureau which has collected statistics of wages and of cost of living in the metal industry, including in its investigation not only the members of its union but many other workers in the metal industry, so that the investigation covered a total of about 2,300,000 workers. It has published the results of its investigation in the *Metallarbeiter*, which is the organ of this powerful union.

According to the statistics of this union about 63 per cent of these workers are receiving wages which are more than 800 per cent greater than those of 1914, about 36 per cent are receiving wages from 500 to 800 per cent greater than in 1914, and the remainder are receiving wages which have not increased as much as 500 per cent since 1914. It is impossible from these statistics to arrive at an average wage increase for the whole of this group of workers.

The trade-unions estimate that the entire cost of living for a family of four has increased about 1,550 per cent since 1914, while Calwer's Bureau (a private statistical bureau), which usually makes use of official statistics, estimates that the cost of food alone for a family of four has increased about 1,470 per cent since 1914.

Quantitative Determination of Potash by the Spectrum

By D. Paul Rogers

THE value of a quantitative determination depends upon three factors; time, cost and accuracy. The fundamental purpose of this experiment is to lessen the time for the determination, to reduce the cost of the chemicals and apparatus and to have a favorable degree of accuracy.

As a result of several determinations in 1918, it was found that the average time for the determination was one hour. This is a saving of time from 50 to 95 per cent over the old standard method of chloroplatinatinic acid method.

A very inexpensive chemical is substituted for the valuable platinum salt which is used in the "chloroplatinate method." An ounce of potassium nitrate when made into solutions is sufficient for hundreds of determinations. When water-soluble potash alone is wanted, there are no chemicals needed. Calcium carbonate and ammonium chloride are the only chemicals needed for determination of total potash. The total cost of chemicals for a determination would not exceed 5c.

Two sets of determinations were made on samples of flue dust containing potash in variable amounts. One of the samples was of a known content. The potash content of another sample was unknown. The latter sample was determined at the same time that an umpire chemist was analyzing by the "chloroplatinate method." These results checked up very reasonably.

Spectrum Method for Potash

This method for determining potash is quite simple in that it measures the intensity of the potassium flame. The method that I worked out requires an accurate eye. The intensity of the potassium flame of various solutions of known content were very accurately recorded. The intensity of the unknown samples were likewise recorded and compared with those of the known potash content.

For a determination of water-soluble potash a 10-g. sample was taken and boiled in about 30 c.c. of water for about half an hour. It was then filtered and concentrated to 10 c.c. For a total potash determination a smaller portion is sintered by the J. Lawrence Smith method, using 0.5 g. of ammonium chloride and 5 g. calcium carbonate. The sintered mass is digested in water and then filtered. The strength of the solution is brought to the same concentration as the above.

A round loop was made on the end of a platinum wire by wrapping it around the lead of a pencil. The purpose of this loop is to have a uniform amount of solution on the film. Satisfactory blue spectacles were used to observe the potassium flame against a white background in a dark room.

Five solutions of potassium nitrate of different strength were made so that they should have a potash equivalent of 5, 7.5, 10.0, 12.5 and 15.0 per cent. For the 5 per cent solution 3.219 g. of the salt was dissolved in 30 c.c. water; 4.8285 g. for the 7.5 per cent; 6.438 g. for the 10.0 per cent; 8.0475 g. for the 12.5 per cent, and 9.657 g. for the 15.0 per cent solution, all in the same amount of water.

Two samples of flue dust of 10 g. each were treated with boiling water for about thirty minutes. The solutions were filtered and concentrated to 10 c.c.

The time of the duration of the potassium flame was determined by dipping the loop of the platinum wire into the solution and then into the flame. Twenty trials on each solution were completed before taking up the next solution. Then the same procedure was used on each of the samples to be analyzed. Each test showed the numbers of seconds of duration of the potassium flame. The following results were obtained:

Trial No.	5 per Cent, Seconds	7.5 per Cent, Seconds	10.0 per Cent, Seconds	12.5 per Cent Seconds	15.0 per Cent, Seconds	Sample 1, Seconds	Samp'e 2. Seconds
1	3	5	4	4	5	3.5	3
2	4	4	4	4	5	3.5	3
3	5	3	3	4	5	4	3
4	3	4	4	4	4	4	4
5	2	3	4	4	5	3.5	3
6	3	3	4	3	5	3.5	3
7	3	3.5	5	3	5	4	3
8	3	3	4	4	5	4	3
9	2	3	5	4	5	3.5	3
10	3	2.5	5	5	5	4	3
11	3	3.5	4	5	5.5	4	3
12	4	3	5	4	5	3.5	3
13	2.5	2.5	3	5	5	4	3
14	2.5	4	3	5	5.5	4	3
15	3	4	4	6	4.5	4	3.5
16	2	3.5	4	5	5.5	4	3.5
17	3	3	3	5	5.5	4	3
18	2.5	4	4	6	5.5	5	3.5
19	3.5	3	3	4	5	4.5	3.5
20	3	4	4	5.5	5.5	5	3.5
Total.....	60	68.5	79	89.5	101.5	79.5	63.5
Average...	3	3.43	3.95	4.48	5.08	3.98	3.18

The average number of seconds of the various samples of solutions of potassium nitrate of known potash content are in progressive order as follows: 3 seconds, 3.5, 4.0, 4.5, 5.0, 4.0, 3.2.

The difference in the above series is only half a second. This half a second is equivalent to 2½ per cent of potash. The average of one-tenth a second will therefore be equivalent to half a per cent of potash.

Sample 1 of the unknowns produced a flame for an average of four seconds. Either calculating or looking

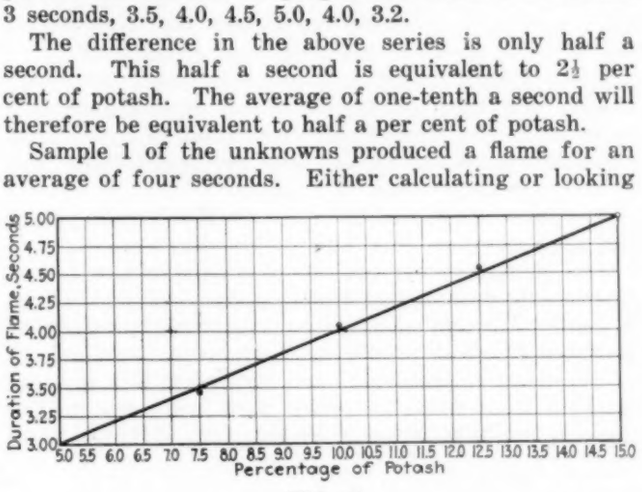


FIG. 1

up the value on the chart of Fig. 1, the percentage of potash in the sample is 10 per cent.

Sample 2 had a flame duration of three and two-tenths seconds. The value of potash here is 6 per cent.

Each one of the samples of the above results was run for the entire twenty trials before taking up the next one. In this way there were no contaminations to interfere with the results obtained.

A second series of determinations of samples 1 and 2 in addition to the solutions of known potash content was made. The following results were obtained:

Solutions	5%	7.5%	10.0%	12.5%	15.0%	No. 1	No. 2
Flame Av., sec.....	3	3.6	4.15	4.6	5.1	4.2	3.15
Progressive order, sec.....	3	3.5	4.0	4.5	5.0	4.2	3.1

From the chart, Fig. 1, the potash of sample is 11 per cent and sample 2 is 5.75 per cent potash.

The average of these results compares accurately with analysis of the standard chloroplatinate method.

	Spectrum No. 1	Spectrum No. 2	Chloroplatinate Method	
K_2O.....	10.00%	6.00%	No. 1	No. 2
K_2O.....	11.00%	5.75%	10.46%	5.90%
Average.....	10.50%	5.88%		

Harrisburg, Pa.

Laboratory Furnace for Deformation Temperature of Refractories

By Leon R. Office

FOR a good many years laboratories that have been testing high-grade refractories, as fireclay, fireclay and silica bricks, silica cements, etc., have been confronted with the problem of a suitable type of furnace that is both cheap in construction and simple of operation and one that can be depended upon day in and day out, without much loss of time for repairs.

The author has in mind such a furnace for which he claims no originality of principle, but which was developed through four years of experience in obtaining the softening and deformation temperatures of various refractories. Innovations were tried, such as: different sized chambers, various types of burners, length of burner, thickness of walls, insulation features, etc., and the type to be described seemed to work advantageously. It is not so difficult to deform pyrometric cone 32 (approx. 1,705 deg. C.) but to reach cones 34 and 35 is more troublesome.

R. T. Stull and J. M. Knote[1] describe a small "pot" furnace of the muffle type, with a combination of up and down draft. It has been the writer's experience that while the temperature may be a trifle more uniform in the muffle, it is also one to three cones lower than in an open furnace and muffle shapes are just complicated enough as to be out of condition most of the time.

C. E. Fulton[2] describes a pot furnace of the "open flame" type, with one burner which gives the flame a spiral motion. This furnace was used in our laboratories for several years and was the basis of the type used at present.

The furnace consists of two parts, the furnace proper and the preheater. Fig. 1 shows the details.

The furnace proper consists of a pot 12 in. wide and 13 in. high, with a chamber 6½ in. in width and 10¾ in. in depth. It was found that a deep and narrow chamber produced the best results, since it has a "stack-effect" of drawing the gases and flame upward with a swirling motion. None of the gas would burn in the center. The pedestal could be varied in height, just so it was above the gas inlet. The "pot" containing the cones is placed on top of the pedestal. The top is one piece, 1¾ in. thick, with a 2-in. inspection hole in the center. If banded with a heavy iron band, its life will be increased several hundred per cent. The furnace must also have an iron band which can be slipped over and bolted on one side.

[1] *Trans.* Am. Ceram. Soc., vol. 12, p. 124.
[2] *Trans.* Am. Ceram. Soc., vol. 16, p. 386.

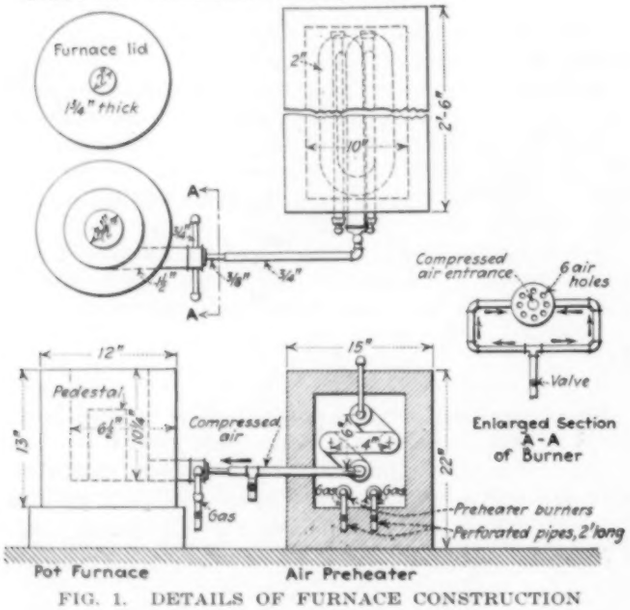


FIG. 1. DETAILS OF FURNACE CONSTRUCTION

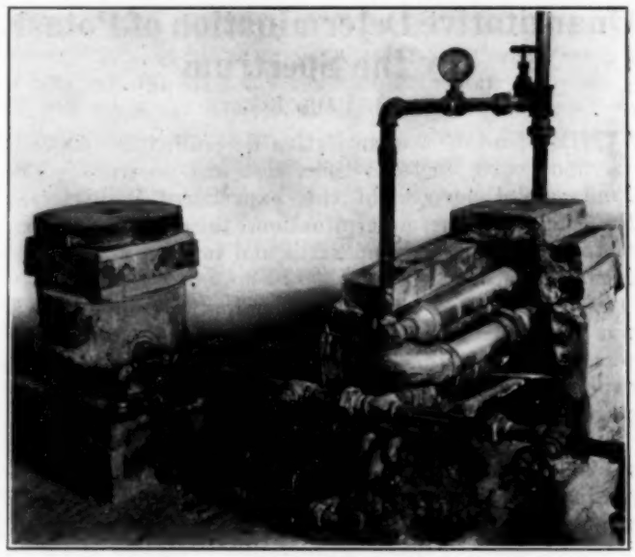


FIG. 2. FURNACE AND AIR PREHEATER

A high-grade fireclay or a mixture of calcined bauxite and plastic fireclay can be used in making the furnace. The better the material the longer and more satisfactory will be its life.

The preheater consists of four lengths of 2-in. iron pipe, connected at the ends with U's and spaced so that the flame from the gas burners below will surround them. The air was not sent through the preheater until the furnace had attained a good red heat, as it increases the temperature too rapidly. Just as soon as air was sent through the preheater into the furnace, the temperature could not be regulated until almost a white heat was reached. With the preheater used, the air reached a temperature of 250 deg. F. at the burner.

Several types of burners on the market were tried, but proved less satisfactory than the homemade one shown in Fig. 1. The nozzle was 1½-in. heavy iron pipe, 6 in. long, connected to a reducing cross which acted as the mixer. Gas entered the mixer through ¾-in. pipes on two sides. A reducing bushing was placed in the rear end of the mixer, with six ⅛-in. holes, equally spaced. The air entered through a ⅜-in. pipe, the opening of which extended just beyond the gas inlets, in order to prevent back pressure on the gas. The air, coming in at high pressure, tended to suck the gas with it and also excess outside air through the six holes in the back of the mixer. With air at 25 to 30 lb. pressure and natural gas in the Pittsburgh district under a pressure of about 2½ lb., a temperature sufficient to melt cone 35 in forty-five minutes was attained. Fig. 2 shows a picture of the apparatus.

This furnace, when made of a good refractory material, is very sturdy and can be used for fifty to sixty runs. Cracks can be instantly patched with Norton's alundum cement and, after several heats, a glaze develops on the inside surface which protects the pot from further attack by the flame.

Pittsburgh, Pa.

Biakmetal

During 1919, it was reported in CHEMICAL & METALLURGICAL ENGINEERING (vol. 21, p. 632), an Italian succeeded in producing a new alloy of zinc and copper, to which the name of Biakmetal was given. For this new alloy it was claimed that it possessed:

(1) The highest known breaking point;
(2) The highest limit of elasticity;
(3) Perfect homogeneity;
(4) High resistance to thermic action;
(5) High resistance to chemical action.

It was further claimed that the new alloy had already proved especially useful in aëronautic and marine construction on account of its light weight, its unusual strength and its anti-corrosive qualities. It was stated that a company with a capital of 12,000,000 lire had been formed to engage in the manufacture of the alloy.

On the strength of these reports, one of the bureaus of the Government which was interested in securing a light metal of great strength obtained through official channels samples of Biakmetal for test. The samples submitted were too small for any tests other than chemical analysis, but this revealed that a variety of different alloys were grouped under the single trade name. Biak No. 2 was an ordinary 60:40 brass containing a little manganese. Biak No. 3 was the same with Ni instead of Mn. Biak No. 4 was a high red brass containing both Ni and Mn. Biak No. 6, was a high-aluminum: zinc: copper alloy, containing a little silicon. Biak No. 9 and No. 19 were high-zinc: aluminum: copper alloys such as have come into use in France for extruding purposes and as bearing metals.

Impact Strength of Carbon Steel

As an addendum to a paper on "Impact Tests on Cast Steel" read before the last meeting of the American Society for Testing Materials, F. C. Langenberg presented a useful table of impact strength of rolled and heat-treated steels. The results given in the table were obtained from specimens cut from bar stock approximately 1 in. in diameter, after various heat treatments. The table shows the composition of the several bars as well as the heat treatment.

Heat-treatment was as follows:

A — Original, as received, probably hot rolled.
B — Annealed just above Ac_3.
C — Hardened in water from just above Ac_3.
D — Hardened in oil from just above Ac_3.
E — Quenched in oil from just above Ac_3, drawn at 375 deg. C.
F — Quenched in oil from just above Ac_3, drawn at 460 deg. C.
G — Quenched in oil from just above Ac_3, drawn at 560 deg. C.
H — Quenched in oil from just above Ac_3, drawn at 650 deg. C.

Recent Developments in the German Chemical Industries

A recent report of the German dye trust states that during 1920 its gross profits amounted to 531.7 million marks. The bulk of this, according to the report, was made mainly during the first half of 1920, since there was a decided drop in business during the latter half of the year. The six works of the trust shared in the gross profits as follows:

	Marks
Badische Anilin- und Soda-Fabrik	194,200,000
Farbwerke vorm. Meister Lucius & Brüning (Höchst)	111,200,000
Farbenfabriken vorm. Friedr. Bayer & Co.	99,700,000
Actien-Gesellschaft für Anilin-Fabrikation	60,700,000
Griesheim-Elektron	41,900,000
Weiler-ter-Meer	24,000,000

The balance sheets of the individual companies make it appear that large reserves have been set aside and that the actual profits were in fact much higher. It must be considered, however, that notwithstanding the fact that the 1920 profits were more than five times as large as in the prosperous year of 1912, they are, when expressed in gold marks, but slightly more than one-third as large. The following figures show the returns for 1912 and 1920 when compared on a gold basis:

	Value in Gold Marks 1912	1920
Badische Anilin- und Soda-Fabrick	27,791,000	12,900,000
Farbwerke vorm. Meister Lucius & Brüning	22,973,000	7,510,000
Farbenfabriken vorm. Friedr. Bayer & Co.	28,746,000	6,650,000
A.-G. für Anilin-Fabrikation	9,738,000	4,070,000
Weiler-ter-Meer	3,379,000	2,790,000
Griesheim-Elektron	8,846,000	1,600,000
Total	101,473,000	35,520,000

All of the individual members of the trust have lately raised their capital stock, ostensibly for the purpose of developing the nitrogen works, although it has been somewhat of a puzzle to observe that this large amount of capital has been set aside for no other visible purpose. This puzzle has now been solved by the recent announcement that arrangements have been made to purchase the stock of the firm of Leopold Cassella & Co., which is the largest German dye manufacturer outside of the combine. The stock of the company is to be taken over by the members of the trust in proportion to their own capital stock.

The dye trust has also assumed complete control of Germany's nitrogen production. This industry was started by the Badische Anilin- und Soda-Fabrik of Ludwigshafen with the works at Oppau, to which were later added the Merseburg and Leuna works. The completion of these plants proved too much of a burden for a single company and for some time past the other members of the dye trust have been contributing necessary funds, although all of the stock was held, at least nominally, by the Badische company. This state of affairs has now been rectified by the formation of the nitrogen combine, equipped with a capital of 500,000,000 marks, held solely by the members of the dye trust. The further capital investment required for completing the works is over 2 billion marks.

RESULTS OF CHARPY TESTS ON FORGED STEELS, CHARPY VALUES IN FT.-LB.

Chemical Composition, per cent.						Charpy Values in ft.-lb. for Various Heat-Treatments.							
C	Mn	S	P	Si	Cr	A	B	C	D	E	F	G	H
0.14	0.45	0.035	0.018	0.131	....	45.39	28.01	38.10	47.18	47.95	49.50	48.34	52.61
0.18	0.56	0.043	0.024	0.132	....	41.51	30.72	35.69	46.24	45.00	44.62	46.87	50.51
0.32	0.51	0.027	0.009	0.128	....	22.96	15.20	10.94	18.85	19.24	19.86	22.34	26.30
0.46	0.40	0.050	0.020	0.144	....	10.70	7.99	.....	14.04	13.96	13.89	15.67	16.60
0.49	0.60	0.028	0.013	0.127	....	12.72	10.32	.....	16.06	14.51	14.35	17.53	19.34
0.57	0.65	0.028	0.012	0.167	....	8.38	7.91	.....	12.57	10.86	11.17	12.02	14.04
0.71	0.67	0.035	0.027	0.147	....	4.42	2.48	.....	.....	4.73	7.60	10.32	15.67
0.83	0.55	0.028	0.018	0.152	....	1.31	1.39	.....	.....	3.42	3.33	4.34	6.36
1.01	0.39	0.029	0.016	0.160	....	2.09	1.47	.....	.....	3.25	3.18	4.19	4.42
1.22	0.34	0.031	0.025	0.181	....	1.39	1.31	.....	.....	2.48	2.09	2.63	2.63
1.39	0.20	0.029	0.015	0.191	....	0.93	0.85	.....	.....	1.86	1.31	1.47	1.62
1.46	0.20	0.035	0.011	0.133	0.35	0.77	1.24	.....	.....	1.94	2.01	2.01	1.94

The nitrogen works are reported to be operating at full capacity with the exception of the Leuna works, which have not yet recovered from the communistic riots of last March. Their production has already made Germany practically independent of the imports of Chilean nitrate and of the large quantities of nitrogen salts formerly received from Norway, Sweden and Switzerland. The imports from Chile, which in 1913 amounted to 774,000 tons, had decreased during the first nine months of 1920 to 31,000 tons. Nitrogen salts from Norway, Sweden and Switzerland fell off from 86,000 tons to 2,500 during the same period.

The world monopoly enjoyed by the German potash industry before the war has been shattered and the industry is now going through a critical period. The competition of Alsace and the heavy freight rates have caused a considerable reduction in exports and the industry is now on the point of shaping a new business policy. It is likely that the future policy will be to export only the richest grades of the crude materials and the refined salts, such as potassium chloride and sulphate.

Due to the short-sighted policy of the Kali Syndikat, which rationed the business in hand according to the number of pits in operation, there has been a large increase in the number of mines, and during the present business depression this has naturally resulted in overproduction. The National Kali Council, which is now the supreme body in control of the industry, has therefore ordered the closing down of all works which by their results show that they cannot operate economically. As a result of the recent amalgamations and purchases the Kali Syndikat now consists of 17 individual members, comprising 175 mines, and representing nearly 80 per cent of the total output.

Synopsis of Recent Chemical & Metallurgical Literature

Subdivision in Sections of the Société de Chimie Industrielle.—At a meeting of the Société de Chimie Industrielle Paul Kestner, the president of the society, described the new subdivisions in sections which, it is expected, will contribute to a better study of the various particular chemical problems. The new sections are: Installation of plants; installation of laboratories, gas and coke; hydrocarbons, petroleum; wood distillation and derivatives; refrigerating; metallurgy and electrometallurgy; precious metals; heavy chemicals; electrochemistry; lime, cement and building material; glass ceramics and enamelled ware; general chemicals; rare earths; radioactivity; dyes; pharmaceuticals; photographic products; powders and explosives; essences, natural and synthetic perfumes; resins, paints, lacquers, varnishes and waxes; rubber and its substitutes; fatty materials, soap, candles, glycerine; cellulose, paper; plastic materials, artificial textiles; bleaching and dyeing; tinctorial and tanning extracts; tanning and allied industries; fermentation sugar, starch and allied industries; dairy industry; food industry. All these sections combined will hold only one annual general meeting.

He also stated that the Société de Chimie Industrielle will co-operate henceforth on a more active scale with the Fédération Nationale des Associations de Chimie and with the Union Internationale de la Chimie Pure et Appliquée.

The National Federation of the Chemical Associations, founded in 1919, consists of the following individual societies: Chemical Society, Society of Chemical Industry, Association of Sugar and Distillery Chemists, Society of Expert Chemists, Society of Physical Chemistry, Society of Biological Chemistry and the Association of Textile Chemistry.

The International Union of Pure and Applied Chemistry, founded also in 1919 (see CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, No. 11, p. 561, June 1, 1919), has now accredited members from twelve countries—namely, Belgium, Canada, Czechoslovakia, Denmark, France, Great Britain, Greece, Holland, Italy, Poland, Spain and the United States. (*La Technique Moderne*, May, 1921.)

Case-Hardening.—Some of the facts and fallacies connected with the subject of case-hardening were dealt with recently in a lecture by Dr. L. Aitchison before the Birmingham Metallurgical Society and reported in the *Ironmonger*, June 11, 1921. The purpose of case-hardening is to enable the use of a material both easy to machine and cheap to produce. The first point to be decided was whether case or core played the more important part, and on this question there was great divergence of opinion, many authorities holding that the former took precedence by reason of its being the actual working part. Referring to the essential properties of both case and core, the lecturer pointed out that "hardness" was the generally accepted term for defining the necessary quality of the case, but "toughness" was really a more suitable word, since it implied a capacity for wear without brittleness. Such toughness could be obtained by the introduction of carbon and other alloys. The core, on the other hand, should emphatically be soft to admit of easy machinability and consequent cheapness in handling; it must also be capable of assuming varying degrees of strength, with a possible range of 60,000 to 170,000 lb. per sq.in.

As to the problem of testing the durability of the treatment, though numerous methods were known, there is not a really satisfactory one available. The degree of surface hardness could be to some extent approximated by scratching with a file; but, at the same time, a steel containing about 5 per cent nickel and 0.2 per cent carbon is readily susceptible to scratching, and yet withstands wear remarkably well, so that the most useful test is microscopic examination, which reveals the nature of the crystalline structure and the depth of hardening. There had been some controversy as to the desirability of a strong or weak core, and it was noteworthy that in aëronautical and automobile engineering where lightness is an essential, strength must not be obtained by increasing weight. There is a certain amount of truth in the popular idea that "once the case is broken the core does not matter"—at all events, an alteration of the strength of the core does not affect the tensile or compressive strength, though it has been found that fracture always occurs at a point corresponding with the core's yield point. Consequently, the raising of this yield point reinforces the case and improves the quality of the whole section. Undoubtedly the impact test pointed to the need of a strong core, and was generally used for measuring toughness. In such an article as a camshaft, where the cam faces alone were hardened, and the intermediate parts unhardened, a high degree of tensile strength is desirable. In determining toughness, which the lecturer considered a very difficult property to define, "fiber" certainly plays an important part, but a fibrous core, while standing up well under a tensile test, does not necessarily resist impact when measured at right angles to the fiber, and therefore the structure should be, as far as possible, of a homogeneous nature.

Dr. Aitchison emphasized the comparative values of cooling methods, mentioning the opinion held by some metallurgists that "when once the temperature attained in refining the core has brought about the required construction, the cooling method is immaterial." From an engineering viewpoint, however, water-cooling has given strengths amounting to 6,000 to 8,000 lb. higher than those resulting from air-cooling. In earlier days, when very mild steels were employed, water-cooling had been universally employed, though steels are now of such vastly improved quality that air-cooling gives satisfactory results in the majority of cases, and is to be recommended whenever possible.

Current Events
in the Chemical and Metallurgical Industries

Dye Embargo Eliminated as Tariff Passes the House

As predicted by the Committee at the time the tariff bill was introduced, it passed the House of Representatives on July 21 by a substantial majority. In the final vote of 289 to 127, the division was almost completely along party lines. The Longworth embargo on dyes, which was the first of the five sections to receive the separate vote of the entire House, was defeated by the scant majority of 16 votes. Oil, hides, cotton and asphalt all remained on the free list of the bill in its final form. The measure now goes to the Senate when it is reported that the Finance Committee will hold extended hearings and will probably postpone final action on the bill until fall, pending consideration of tax legislation.

The chemical schedule came in for somewhat more than its share of discussion, for under the special cloture rule obtained by the Committee, three of the five sections open to amendment related to chemical products. These were dyes, petroleum and asphalt. The great preponderance of debate centered on the Committee's proposed 3-year embargo on dyes and coal-tar chemicals. After three days of heated debate, the House on July 16, voting as a committee of the whole, refused to accept any amendments to the section by a vote of 122 to 109. When the entire bill was called up before the House proper on July 21, however, Representative Frear moved that all of par. 27 which provided for the embargo control be eliminated from the chemical schedule. A number of Democrats, who had previously supported the measure, swung to the opposition and succeeded in defeating the embargo by a vote of 209 to 193. In the bill as passed by the House, coal-tar crudes remain on the free list, intermediates receive a protective duty of 30 per cent plus 7c. per lb., and dyes and finished coal-tar products are dutiable at 35 per cent plus 7c. per lb.

Changes in Chemical Schedule

Among other last-minute changes in the bill was the increase in the duty on citrate of lime from 2½c. to 7c. per pound. Citric acid, which should logically have received a greater compensatory duty, was raised only to 12c. An important change was made in the rate on camphor which the Committee had fixed at 25 per cent ad valorem. Crude camphor remained dutiable at 1c. per lb. as in the present law while the rates on refined and synthete were increased to 6c. per lb. The duty on ethyl alcohol was changed to 15c. per proof gallon. The quicksilver tariff was increased 500 per cent on the recommendation of the Secretary of War and a compensating increase on vermilion reds was approved.

The provision for a duty on imported petroleum oil was defeated after a sharp conflict between representatives from New England and from Oklahoma and Kansas, the centers for the independent oil producers. Following the reading of a letter from President Harding, Representative Treadway, of Massachusetts, succeeded in obtaining the passage of an amendment to return petroleum to the free list.

Asphalt was also returned to the free list after the House had rejected various proposed duties ranging from 50 cents to $3 per ton. The committee later introduced some 200 so-called "perfecting" amendments, most of which were designed to correct spelling and other minor inconsistencies although in certain cases substantial increases in rates were included.

Following the scathing denunciation of the dye bill in his recent minority report, Congressman Frear of Wisconsin led a vigorous attack on the measure and was supported on the floor of the House of Representatives Burroughs of New Hampshire, Black of Texas, Fish of New York, Tague of Massachusetts and Moore of Virginia.

Dye Embargo Defended by Longworth and Others

The bill was ably defended in speeches by Representatives Longworth, Copley and Hadley, who composed the sub-committee in charge of chemicals. Others to take up the fight in favor of special protection for the dye industry included Green of Iowa (who was largely responsible for the legal features of the measure); Treadway of Massachusetts, Graham of Illinois, Snyder and Magee of New York, and Tilson of Connecticut.

Representative Frear on a number of occasions charged that the dye industry was a half-billion dollar monopoly, represented largely by the Chemical Foundation, which was characterized as a private company that had defrauded the government of $10,000,000 worth of patents. Frear also continued his attack on the officials of the Foundation.

In replying to Mr. Frear, Representative Longworth pointed out that only a very small proportion of the dyes produced in this country were affected by the Foundation's patents, and while offering no defense of the corporation, he explained its organization and principles. The Tariff Commission's report on dyes in 1920 which is referred to on page 166 of this issue, was quoted to show that no monopoly existed in the industry. In referring to the important relation to the National Defense, reference was made to the messages of former President Wilson, and the following letter from General Pershing was read:

GENERAL OF THE ARMIES,

Washington, July 15, 1921.

Hon. NICHOLAS LONGWORTH,
House of Representatives, Washington, D. C.

DEAR MR. LONGWORTH: With reference to the protection for the dye industry in this country, it can be stated that the coal-tar products, of which dyes are the most important at present in peace, is the base of practically all of our high explosives and most of our war gases.

Our shortage of chemical plants in general, and dye plants in particular, prior to the World War, made it difficult for us to obtain a supply of high explosives and gases until we had been in the war for several months.

From the above the importance of the chemical industry from a military standpoint will be readily seen.

Sincerely yours,

JOHN J. PERSHING.

Protests against Potash and other Duties

An idea of the opposition certain to meet the potash duty in the Senate may be gained from the remarks in the House—where it did not come up for a separate vote—by Representative Larsen, of Georgia. "The domestic potash industry," said Mr. Larsen, "has been in existence five years. For four years, it has enjoyed a complete monopoly and prices have been the highest in the history of the country, yet it has never produced more than twenty per cent of our normal demand. If at $500 per ton, the industry were able to produce only 20 per cent of the normal demand, how is it going to produce potash under present conditions so it will be profitable to the industry or to the consumer?"

Among other duties to be protested are the proposed levies on vegetable oils, including olive oil. The soap manufacturers and other consumers have organized a bureau of free raw materials and have appealed to the President for more liberal tariff treatment for the materials entering into the manufacture of soap, lard and butter substitutes, paints, leather and allied materials.

Census of Dyes and Coal-Tar Chemicals for 1920

The fourth annual report on the production of dyes and other coal-tar products during 1920, which has been issued recently by the United States Tariff Commission, shows remarkable developments in these important industries. The progress made during the year is evidenced by the fact that the output of dyes increased over 40 per cent, reaching a total of 88,263,776 lb., valued at $95,613,749. This exceeds the imports of 1914 by 92 per cent. In general the dyes used in large quantities were made in amounts sufficient to supply American needs. A number were made in considerable excess of domestic requirements and this contributed to the development of a large export trade in dyes during 1920. The American manufacturer, having met the demand for the dyes consumed in largest quantities, is now turning his attention toward the production of the many so-called "specialties," which while of secondary importance as far as quantity is concerned, are nevertheless essential to the establishment of a well-rounded and self-contained dye industry.

Intermediates and Dyes

The quantity of intermediates produced in 1920 showed an increase of 45 per cent over the output in 1919. The total production was 257,726,911 lb., valued at $95,291,686. Of the more fundamental intermediates, aniline oil increased 61 per cent over the 1919 figure; beta-naphthol, 147 per cent; dimethylaniline, 53 per cent; gamma-acid, 170 per cent; H-acid, 35 per cent; alpha-naphthylamine, 233 per cent; paranitraniline, 63 per cent; and benzidine base, 91 per cent.

The production of anthraquinone increased from 294,260 lb., valued at $547,787, in 1919 to 539,619 lb., valued at $894,418. This increase is due in part to the development of synthetic anthraquinone from phthalic anhydride and benzene.

Triphenylphosphate and tricresylphosphate, used as substitutes for camphor in pyroxylin plastics, first appeared in 1920. It is doubtful whether these products can replace camphor for all purposes, but they at least offer a possible means of becoming independent of the Japanese camphor monopoly.

There were 360 or more different dyes produced by eighty-two American manufacturers in 1920. The output of these dyes, by classes according to their method of application, is shown in the accompanying diagram, which also offers a means of comparing this production with that of previous years (1917, 1918 and 1919) and with the imports for 1914 and 1920. The pre-war imports, which in many cases have been more than doubled, are exceeded for all classes except for "vat dyes other than indigo." That real progress was made in this class, however, is evidenced by the increase from an output of 389,158 lb. in 1919 to 1,159,868 lb. in 1920. The output of indigo, 18,178,231 lb., valued at $13,497,981, exceeds the production of 1919 by 105 per cent and is 116 per cent greater than the importations during 1914. Sulphur black, which has previously been the first color in quantity produced, ranks second in 1920 with an output of 16,305,037 lb.

Production and Imports

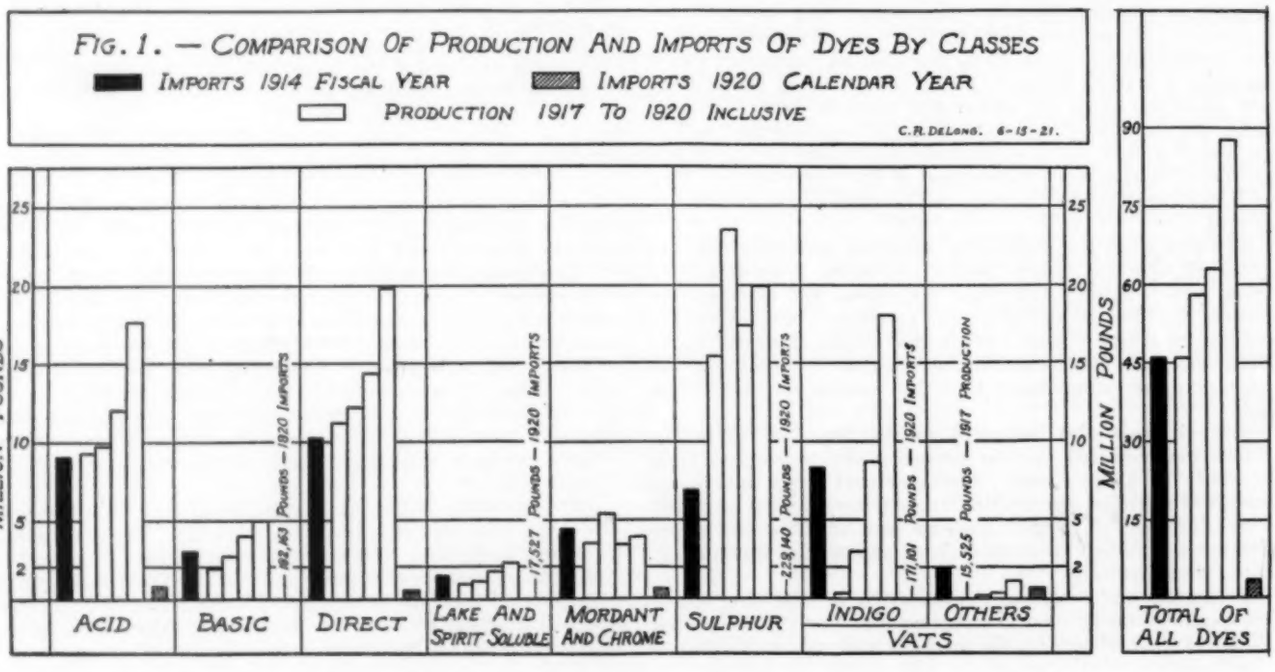
A significant fact shown by the Tariff Commission's report is that of the 360 dyes produced in 1920, 108 individual colors, representing 92 per cent of the total output, were each manufactured by three or more firms. Of still greater significance is the fact that thirty-five dyes amounting to 52 per cent of the total, were each manufactured by seven or more separate firms. The dyes manufactured by only one firm numbered 200, but their output represented only 5 per cent of the total domestic production.

It is interesting to note that a consideration of the value of production, imports and exports shows that the value of the domestic output in 1920 was equal to at least 120 per cent of the domestic consumption, or exactly double the 60 per cent requirement of the tariff act of Sept. 8, 1916.

Among the other finished products derived from coal tar, there were conspicuous increases in the output of synthetic tanning materials, color lakes, perfume materials and synthetic phenolic resins. Some progress was reported in the manufacture of photographic chemicals, but there were marked decreases in the case of coal-tar medicinals and flavors.

In addition to the detailed production statistics, the report contains an analysis of dye importations, which classifies the foreign colors according to Schultz numbers and shows their manufacturers, quantities imported, invoice values and countries of origin. The results of this study had already been outlined in a preliminary statement by C. R. DeLong of the Tariff Commission's staff, which was published in Chem. & Met., vol. 24, p. 845, May 11, 1921.

Other features of the report include the studies of rates of pay to employees with and without technical training, and also the amounts spent for research by the different manufacturers. The proportion of the monthly output of the German dye plants which is reserved for the option of the Reparations Commission is shown for the last eleven months of 1920 and the first three months of 1921. The appendix of that report includes a directory of the domestic manufacturers of coal-tar products during 1920.



Fixed Nitrogen Research Laboratory

The Department of Agriculture has authorized the following official statement in connection with the transfer of the Fixed Nitrogen Research Laboratory from the War Department to the Department of Agriculture. The statement follows in its entirety:

By an order of the President, the Fixed Nitrogen Research Laboratory in Washington, D. C., established for war purposes in 1919, has been transferred from the War Department to the Department of Agriculture. This means that the research work to discover methods of fixing nitrogen from the air and making it available for use will be continued, and the results will be available for agricultural and chemical purposes.

The War Department, in making the transfer, included a provision, which was approved by the President, that the work of the laboratories should be available for the War Department at such times as national defense should make it imperative. A personnel of 110 to 120, including 50 of the best-trained experts in the world in nitrogen fixation and the application of the product, is transferred from the War Department to the Department of Agriculture, with the assurance that this carefully selected group of workers will be kept together instead of drifting into private occupation.

Dr. R. C. Tolman, Director of Fixed Nitrogen Research, will remain in the same position. The method of control of the research work under the Department of Agriculture has not been worked out in detail. The sum of $500,000 made available from funds in the control of the President is transferred for the maintenance of the work for the next two years.

The laboratory is located on the grounds of the American University on Massachusetts Ave., Washington, making use of buildings and equipment formerly used by the Research Division of the Chemical Warfare Service. The largest building in use is loaned by the American University.

The Fixed Nitrogen Research Laboratory was founded by an order of the Secretary of War dated March 29, 1919, and has been operated with a budget of $300,000 a year, the funds being provided under the National Defense Act of June 3, 1916, which authorized the President of the United States to "cause to be made such investigations as in his judgment are necessary to determine the best, cheapest, and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other useful products, by water power or any other power, as in his judgment is the best and cheapest to use."

Work of the Laboratory

The main work of the laboratory has been to study the fixation of nitrogen by the cyanamide, the Haber and the arc processes, and to study the methods of transforming the various forms of nitrogen-containing products so as to make them most available for military, agricultural or industrial uses.

The cyanamide process is the one designed to be used at the Muscle Shoals plant in Alabama, and the Haber process in the smaller Sheffield plant in the same state, while the arc process is regarded as one of the most important processes of nitrogen fixation from a military point of view, since it can be most rapidly installed in case of war, and since it provides nitrogen at once in the nitrate form without the necessity of any oxidation from the ammonia form. The Government owns no arc plant, and for this reason less attention has so far been given to this process than to the others.

The cyanamide process is one of the best-known and best-established methods of fixing nitrogen, and the laboratory has completed more work in connection with this process than with the other methods of nitrogen fixation. The cyanamide process is at present the only process by which nitrogen can be fixed in America in case of emergency. The work on cyanamide was originally undertaken at the specific direction of the Fixed Nitrogen Administrator, Arthur Graham Glasgow, because of the Government ownership of the great Muscle Shoals plant, which is expected to produce 220,000 tons of cyanamide per annum.

The main purpose of this work has been to study cyanamide and its various possible transformation products from the point of view of their utility in agriculture, explosives and the arts. The laboratory has already collected an enormous amount of information as to the various compounds which can be prepared from this material. A large amount of further information is now coming through in the form of additional reports, and a number of important experimental investigations are being brought to a close. Experts in the Washington laboratory believe that the cyanamide process will remain an important method of fixing nitrogen for many years to come.

The Haber process, which under certain industrial conditions can displace the cyanamide process, has never been commercially operated outside of Germany. It has very great inherent difficulties connected with handling large quantities of flammable gas at high pressures and high temperatures.

While the research laboratory was established under the War Department and with a particular view to working out explosives problems, the necessity of obtaining a nitrogen supply for agricultural purposes has been kept constantly in mind. Pot and field tests have been carried on in co-operation with the Bureau of Plant Industry of the Department of Agriculture and at the two Alabama plants, where 20 acres were given over to agricultural tests in 1920. The closest co-operation has been maintained between the two departments in this work, and Dr. R. O. E. Davis, Scientist in Charge of Soil Physical Investigations of the Bureau of Soils, has been assigned for some time to co-operate with the work at the laboratory. Samples of fertilizer material for next year's tests at the plants are now being prepared by the laboratory.

Owing to the great variability in the results obtained in field tests, the experts are very anxious to continue the work for another year. The laboratory has already collected very important information as to the behavior of about 10 nitrogen-containing substances to these field tests.

Needs of Nitrogen Supply

Nitrogen is one of the three great elements necessary in fertilizers for plants, the others being phosphoric acid and potash. Nitrogen forms an essential constituent of explosives, of fertilizers, of dyestuffs, and many other substances used in the arts. In time of war the necessity of importing Chilean saltpeter, with its attendant uncertainties and tie-up of carrying capacity, was very serious. In time of peace the use of nitrogen in fertilizers is limited only by the supply and, if available, larger quantities would be used for increasing the food and other crops necessary for the country's welfare. It has been estimated by a high authority that the total loss of nitrogen from the arable land under cultivation in the United States is equivalent to 15 to 20 million tons of ammonium sulphate a year, representing a material work of about $1,000,000,000.

A peculiarity of nitrogen fixation research in contrast to many other lines of scientific investigation is the rigid secrecy maintained by each country because of the great advantage of a supply of fixed nitrogen in time of war. Thus, although Germany has carried on extensive research for years, the results have not been made available and it has been necessary for the American scientists to start from rather rudimentary beginnings and build. The laboratory and personnel are considered the best on this continent, and possibly in the world.

Slate Industry Utilizing Waste

Theories for utilizing waste at slate quarries are being put into practice quite generally, according to Dr. Oliver Bowles, of the U. S. Bureau of Mines, after a visit to a number of quarries in the East and in New England. One large quarry is at this time installing a grinding plant to produce a 200-mesh product for filler purposes. There is an increasing demand for this type of material for filler in roofing and linoleums, and in asphalt mixtures.

While the activities at slate quarries are at a low point at present, steps are being taken in preparation for an increased volume of business which it is believed is certain to come with the increase in building activities.

Secretary Hoover Comments on Ford's Muscle Shoals Offer

The Secretary of Commerce revealed on July 18 that Henry Ford is not the only private interest considering the Muscle Shoals power proposition. Secretary Hoover stated that various chemical and power companies were considering the matter and indicating an active interest in it.

The Henry Ford proposition, and this has been confirmed at the Department of Commerce, is as follows: Mr. Ford offers to lease for 100 years the Wilson dam and the nearby No. 3 dam, along with the electrical installation, when the project is completed. It is estimated that an additional $28,000,000 must be expended for the completion of the dam. On that sum, Mr. Ford proposes to pay interest at the rate of six per cent, and to amortize not only this sum but the entire cost of both dams over a period of 100 years. In addition he offers $5,000,000 for the outright purchase of nitrate plant No. 2, its auxiliary steam plant, the land necessary to the operation and other appurtenances. He agrees to operate the nitrate plant for the production of fertilizers and to make the necessary conversion of the plant. He agrees also to maintain the plant so that it may be converted promptly for the manufacture of explosives in case of war. The plant is to be kept up to date in both arts. He agrees also to limit the profits of the fertilizer plant to eight per cent.

Mr. Ford expects to use a part of the power not needed for the nitrate plant for some of his own manufacturing enterprises and in addition it is assumed that he will undertake to find buyers for the surplus power. The Secretary of Commerce authorized the following statement in regard to Mr. Ford's proposal:

"The acceptance of the offer is matter for decision by Congress and that body will no doubt be greatly guided by Secretary Weeks' views in the matter. Mr. Ford has made a genuine proposal. It shows courage to agree to pay out $5,000,000; to spend further sums upon large works and besides to take an annual obligation for about $1,500,000 for 100 years and to agree to maintain a nitrate plant in reserve for the government for that period. Whatever may be the result, Mr. Ford's offer does prove what the public associations have contended—that the completion of this project has a commercial value."

Minerals Separation North American Corporation a Party to Miami Suit

On July 15, 1921, Judge Morris, in the U. S. District Court, Wilmington, Del., granted the petition of Minerals Separation, Ltd., and Minerals Separation North American Corporation that the latter company be made party in the suit in Minerals Separation, Ltd., vs. Miami Copper Company.

The granting of such a petition is of very little general interest since it matters not just which of the various corporate organizations of Minerals Separation, Ltd., are or are not parties in this suit.

But had Judge Morris, upon the other hand, found, as was claimed by the Miami Copper Company, that Minerals Separation had upon July 8, 1913, actually transferred its legal interest in its patents to the American corporation some very interesting and possibly far-reaching questions would have arisen as to the status of the suit now being prosecuted and also as to the disclaimer made by Minerals Separation, Ltd., as to certain claims of patent 835,120.

Stanley Patent Bill Again Delayed

The Stanley patent bill, requiring foreigners who take out American patents to undertake manufacture within the United States, was reached on the Senate calendar July 18, but was not considered, due to objection on the part of Senator Smoot, of Utah. Senator Smoot said that he had taken up some phases of this legislation with the Commissioner of Patents and is awaiting a reply. Pending receipt of that reply, he asked that the legislative consideration of the bill be postponed.

Another Moses Amendment

In explaining an amendment, which he has offered to the section of the Fordney tariff bill relating to dyes and coal-tar products, Senator Moses said:

"I propose to eliminate the embargo feature which the monopolistic dyestuff makers of America insist upon having in violation of the promises repeatedly made to committees of Congress in both Houses, and to give them instead a straight tariff protection in an amount wholly sufficient to cover the adverse labor costs obtaining in European countries, and adding a sufficient protection to give American dyestuff makers a consistent advantage in those markets. I intend to amplify this amendment in the course of the debate in the Senate when the tariff bill comes to us; and my only comment is that any manufacturer desiring a larger measure of protection than my amendment provides for him is a consummate hog."

The tariff protection provided in Senator Moses' amendment is accomplished by substituting for the ad valorem rates on dyes and intermediates, a special duty equal to the amount by which the American selling price plus 20 per cent of such price shall exceed the foreign market value to which has been added the specific duty of 7 cents per pound and certain non-dutiable charges for shipping and packing. In other words, the duty provides for the spread between the foreign and domestic prices and then adds an additional 20 per cent of the latter price. A foreign dye, under such an arrangement, will cost at least 20 per cent more than the identical American product. In case there is no comparable American dye or the foreign market value can not be determined, the amendment proposes alternative procedures based on costs of production.

The United States Tariff Commission is to supply the Secretary of the Treasury with the information required by the collectors of customs for the administration of the suggested measure.

Fall Meeting, American Electrochemical Society

In accordance with its policy of planning technical sessions well in advance so that members having research under way or papers in prospect will have an opportunity to complete them, the American Electrochemical Society has decided to hold a symposium on gases of the electrochemical industries at its spring meeting in 1922. The subject will include gases produced directly by electrolysis, their properties and uses; byproduct gases, their properties and uses; gas produced from electrochemical and electrothermal products, their generation, properties and uses. W. S. Landis, 511 Fifth Ave., New York City, is in charge of the symposium. Particular attention should be paid to new processes of generation, new uses and particularly to a compilation of newly discovered properties or of revised constants of the various gases in question.

It is announced that plans for the Lake Placid meeting, September 29, 30 and October 1, are proceeding satisfactorily. Lake Placid is recognized as a delightful mountain resort, and members of the society will find this meeting highly enjoyable. Plans are under way for outdoor sports in addition to the technical sessions. The latter will include symposia on non-ferrous electrometallurgy and electrodeposition.

Plans for Fall Meeting, Dye Division, A.C.S.

On Wednesday and Thursday, September 7 and 8, the Dye Division of the American Chemical Society will holds its fall meeting in New York City. This and other divisional meetings will be held in the buildings of Columbia University.

In addition to the usual scientific program, there will be an election of officers, and also discussion relating to matters of interest to the Dye Division.

An unusual effort will be made this fall to have the scientific papers read before the division of considerable interest. The secretary, R. Norris Shreve, 43 Fifth Ave., New York City, asks members to let him know at once about any papers which they can present, pertaining to the chemistry of the manufacture, use or application of dyes and intermediates.

Fermogas Promoter Sent to Prison

Stanislaws C. Papp, 41 years old, a chemist, who in May, 1920, caused a stir when he announced he had discovered that the juice of corn stalks, plus a little sugar, could be made into a substitute for gasoline in the operation of automobiles, was sentenced to from two and a half to five years in Sing Sing when arraigned before Judge McIntyre on July 19.

He had pleaded guilty to six indictments charging him with posing as "Professor F. John Chassler" when he induced many poor Hungarians and others to purchase stock in the Fermogas Company, a $1,000,000 corporation, which he organized after he had given several fraudulent demonstrations of his "discovery" to army officers, bankers and capitalists in Ramsey, N. J.

Assistant District Attorney Lazarus told Judge McIntyre that the "professor" opened an office at 10 East Thirty-ninth Street for the disposal of stock in his "fermogas" company to victims, and that he maintained a "laboratory" at his home at 5,614 Second Avenue, Brooklyn. He gave a demonstration of his "product," Mr. Lazarus said; but it was found later that the "professor" had an old pipe running to the vat containing the ingredients for the gasoline substitute, which pumped perfectly good gasoline into the automobile in which he gave his demonstration.

New York Meeting, American Chemical Society

The fall meeting of the American Chemical Society will be held with the New York Section, Tuesday September 6 to Saturday, September 10. This will probably be the largest meeting of the American Chemical Society that has ever been held. Aside from the 2,500 members of the New York Section itself, many thousands are within a four or five hours' ride of New York. In addition to the usual features the society will have as guests at this time a considerable number of British and Canadian members of the Society of Chemical Industry who will have held their annual meeting in Canada, will be greeted at the border by the Governor of the State, and will arrive in New York on Wednesday morning, September 7. After being the guests of the American Section of the Society of Chemical Industry at a Luncheon September 7, they then become the guests of the American Chemical Society for the remainder of the week. At least three or four hundred of these British and Canadian friends are expected, besides three or four thousand from the American Chemical Society. All members of the American Chemical Society are invited to the meeting in Montreal, beginning August 29th.

A further reason for this being a large and successful meeting is the opening of the National Exposition of Chemical Industries on September 12, immediately after the close of the meeting. A great many guests from all over the United States who visit this Exposition each year, will come a few days earlier to attend the meeting of the American Chemical Society.

Divisional Programs

All Divisions will meet. Meetings are also announced of Sections of Sugar Chemistry, Cellulose Chemistry, Leather Chemistry, Petroleum Chemistry, and Chemical Education. All Divisions and Sections will have two full days at their disposal.

The Division of Industrial and Engineering Chemistry calls especial attention to two items on its program: First, a symposium on filtration, being organized by D R. Sperry of Batavia, Ill.; and second, a symposium on gas chemistry being organized by a committee of which R. S. McBride, Colorado Building, Washington, D. C., is secretary.

Notice of the Dye Division's plans will be found elsewhere in this issue.

The Division of Chemistry of Medicinal Products will devote the largest portion of their time to a discussion of the "newer synthetics as used in medicine."

The Division of Biological Chemistry will hold an all-day symposium on vitamines with Prof. H. C. Sherman as chairman. Tentative plans include discussion of fat-soluble A, water-soluble E, antineuritic vitamine, antiscorbutic vitamine, stable forms of vitamine, the physical chemistry of vitamines, and vitamines from the standpoint of structural chemistry. Among the speakers will be such authorities as Mendel, Osborne, Hess, McCollum, Emmett, Seidell, Steenbock, Funk, Dutcher, Williams, La Mer, and Blunt. The great interest in the vitamine papers presented at Rochester has led the officers of the division to anticipate an unusually interesting symposium and valuable discussions.

The Cellulose Section will hold a symposium on cellulose esters. Reports by the committee on viscosity standards and by the committee on the preparation of a standard cellulose will be received.

The Leather Section already has some twenty-five papers in hand for the meeting of that section.

The meeting of a Section on Chemical Education with Edgar F. Smith as chairman and Neil E. Gordon as secretary has been authorized for the New York meeting.

The Petroleum Section will hold a symposium on emulsification problems in the petroleum industry.

Bureau of Chemistry Directorship Unattractive to Many

In feeling out a considerable number of men prominent in the field of agricultural and food chemistry and in organic research, officials of the Department of Agriculture are finding that few of these chemists are in a position to accept appointment as Chief of the Bureau of Chemistry at $5,000 a year. In private industry a chemist capable of directing the work of 300 technical men and 400 other assistants receives a salary of several times $5,000. Many chemists of this type would be glad to do public service if they could afford it, but it is apparent from the investigation which the department has made that not many men are in a position to make this sacrifice.

The resignation of Dr. C. L. Alsberg became effective July 15. At the request of the Secretary of Agriculture he remained in Washington for a number of days after that date but the fact that his new duties at Leland Stanford require his early presence in California precludes his devoting more time to the bureau. This is expected to hasten the matter of selecting the new chief. The problem admittedly is simply one of persuading some properly qualified chemist to work for $5,000 a year.

Chemical Exposition Notes

Filters

In the approved methods of today efficiency in every branch of factory or plant is demanded. In filters, the advantages looked for are labor saving, saving of filter cloths, perfect filtration, low cost of maintenance, perfectly clear filtrate, clean installation, high capacities, low moisture content.

All of these requirements have been met by exhibitors of filters at the Seventh National Exposition of Chemical Industries, Eighth Coast Artillery Armory, New York, Sept. 12 to 17. An open tank filter which requires only one man to operate hundreds of square feet of filter area will be one of the exhibits.

A rotary continuous suction filter, superior for handling mud from hot, caustic solutions from continuous causticizing and lime recovery is a typical American product.

Large sums are spent annually by manufacturers experimenting with the clarity and keeping quality of their products. The opportunities for research and investigation at the exposition will be invaluable in obtaining filtering efficiency.

Platinum Theft at Sierra Magnesite Co.

The Sierra Magnesite Co., Porterville, Cal., reports the theft of platinum from its laboratories some time during the night of June 14, comprising three platinum crucibles weighing, respectively, 12.1 g., 12.328 g., 14.307 g. In addition to these there was taken one palau crucible weighing 14.491 g.

Personal

DR. HARDEE CHAMBLISS has been placed in charge of the Department of Chemistry of the Catholic University, Washington, D. C. He will be in immediate charge of the Martin-Maloney laboratory. Dr. Chambliss was graduated from Johns Hopkins University in 1900. He has devoted practically his entire time since in chemical research and instruction. During the war he was in charge of the Government's nitrate plant No. 1 at Sheffield, Alabama. Dr.. Chambliss succeeds Rev. John J. Griffin, who has been in charge of the University's Department of Chemistry since 1895. Dr. Griffin was compelled to abandon the work on account of ill health.

W. J. CROOK, formerly chief metallurgist of the Pacific Coast Steel Co., has been appointed associate professor of metallurgy at Stanford University. Mr. Crook is retained by the steel company in a consulting capacity.

DR. GRAHAM EDGAR of the University of Virginia is associated with the research work of the Fixed Nitrogen Research Laboratories, American University, Washington, for the summer. Dr. Edgar previously was connected with this organization and has returned to the work to round out some of the investigations in which he has been engaged previously.

O. B. HOFSTRAND, metallurgical engineer, of Salt Lake City, Utah, has recently returned after having completed an extensive investigation of the Tintic Milling Company's plant and process at Silver City, Utah.

DR. R. B. MOORE, chief chemist of the U. S. Bureau of Mines, will leave Washington August 2nd for a month's trip during which he will look over the chemical phases of the work being done at Bureau of Mines experiment stations at Pittsburgh, Columbus, St. Louis, Denver, Salt Lake City, Reno, and San Francisco.

DR. WALTER F. RITTMAN is to assume duty as head of the Department of Commercial Engineering, Carnegie Institute of Technology, Pittsburgh, Pa., next fall.

WELD, LIDDELL & LAZENBY have dissolved the partnership. Messrs C. Minot Weld and Donald M. Liddell will continue to practice as consulting engineers and economists under the name of Weld and Liddell, at 2 Rector Street, New York. Paul H. Lazenby will continue his practice independently in transportation business, public utilities and economics, with offices at 2 Rector Street, New York.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 22, 1921.

Chemicals are finding a quiet outlet in most instances and price changes have been confined to comparatively few items. Second hands have been kept moderately active, but they are not getting any real assistance from consumers who prefer to operate only for necessary requirements. Prices advanced slightly at intervals then declined to where they were previously. The movement depended chiefly on whether the principal wanted to buy or sell. Looking at the big basic chemicals, we find a slight shading of prices for resale *caustic soda* at the works. This is not due entirely to speculative short selling, as some of the more prominent dealers have sold down to 3¾c. per lb. against a 4c. price at the close of the previous week. The market has been well restricted on resale stock to the range of 3¾@4c. per lb. Offerings of large tonnages of German caustic soda at $3.35 per hundred lbs. attracted considerable attention and found ready buyers. *Soda ash* has not been altered to any noticeable extent on spot. Prices ranged from $2.05@$2.10 per 100 lb. and closed at the inside figure in single bags in most resale quarters. *Bleaching powder* was handled to some extent for paper mills at $2@$2.10 per lb. f.o.b. works and closed rather firm at these prices which were named by large dealers. *Bichromate of soda* showed a slight decrease at the close of the week. *Oxalic acid* remained fairly steady and appeared to be somewhat under control. Aside from tartaric acid, the smaller items were quite steady with camphor, quinine and menthol showing a disposition to strengthen. *Prussiate of soda* slumped about ¼c. per lb. under keener competition. *Caustic potash* was easy while imported *chlorate of potash* seemed a bit steadier. *Copper sulphate* was in moderate request remained steady. Second hands are quoting producers' prices on standard quality and it looks as though resale supplies of this chemical have been well liquidated.

Textile mills are buying some material and a better feeling has developed in the tanning industry. The usual depression in business has been reported from the glass plants where summer slackness has been in order. Paper mills seem to be buying more freely and quite a few inquiries have resulted in the placing of some large orders. There are distinct indications of a moderate increase in the volume of the general merchadise business. The building trade has taken a decidedly better turn and this condition has developed an increased demand for building materials. There has been some noteworthy improvement in the credit situation. All danger of a credit strain has definitely passed. The general condition of business in this country is greatly disjointed, but there is no serious alarm for a general depression. Although the copper mines are closed down and the steel industry is operating at 25 per cent capacity, these industries as well as others cannot through any possibility remain permanently stagnant.

CHEMICALS

Producers of *acetate of soda* report sales on the basis of 4c. per lb. and quote the market 4@4¼c. depending on quantity. This is the lowest price quoted in the open market so far this year and compares with a high price of 12¼c. established in May, 1920, and a high price of 6¼c. recorded in January and February, 1921. First hand sales of *bicarbonate of soda* are going through on the basis of 2¼c. per lb. f.o.b. works in barrels and 2½c. per lb. in kegs. Dealers are offering prime material at $2.35 per 100 lb. in bbls. ex-store and report a rather calm market. Spot *bichromate of soda* appeared somewhat steadier at the close and 8c. per lb. was the minimum for standard material. Sellers reported quiet trading at 8@8¼c. per lb. Most dealers of *caustic soda* quoted the market for standard brands at $4@$4.15 per 100 lb. ex-store N. Y. At the works dealers quoted 3¾@4c. per lb. depending upon the quantity. Contracts are quoted by producers at 3¼c. per lb., basis 60 per cent, f.o.b. works. Moderate trading has featured the market and transactions have been along conservative line in most instances. Some German caustic soda was offered at $3.65 per 100 lb. ex dock N. Y. Manufacturers report sales of *hyposulphite of soda* at 3¼c. per lb. in bbls. for carload lots. Smaller quantities are moving at prices ranging up to $3.85 per 100 lb. A fair inquiry has reached the market during the past week. Spot *nitrate of soda* was offered at 7@7¼c. per lb., while some sellers are asking above this figure. Light trading is about the best that can be said of the market at present and the desire to secure new business has prompted slight price shading in some directions. Lower prices are reported for *prussiate of soda* on spot. Sales have been rumored down to 11¼c. per lb., but the general quotation was 11¾@12c. per lb. according to quantity. This is another chemical that has felt he depressing influence of selling competition. Buyers are chiefly interested in small lots. Dealers' prices on resale light *soda ash* in single bags range from $2.05@$2.10 per 100 lb. Barrels were offered at $2.40@$2.50 according to seller and quantity. Resale offerings at the works were quoted at $1.85@$1.95 per 100 lb. First hand prices at the works were heard at $1.60 per 100 lb. for single bags, basic 48 per cent. Imported ash was obtainable in limited quantities at $1.55 per 100 lb. ex-dock N. Y. Prime domestic *sulphide of soda*, fused, is quoted by producers at 6¼c. per

lb. which resale material has been offered at prices ranging from 5@5½c. per lb. The broken variety is quoted at 5½@6½c. per lb.

Business in *barium chloride* has shown a little more activity of late with dealers holding spot material at $59@$60 per ton. Sales for immediate shipment from abroad were reported at $55@$57 per ton. Producers of *bleaching powder* continue to ask 2¾c. per lb. for large drums at the works regardless of rumors to the effect that lower prices have been named. Prominent dealers quote the market at $2@$2.10 per 100 lb. f.o.b. works and 2¼@2¾c. per lb. for small drums. Miscellaneous inquiries have resulted in some additional business being placed, but buyers seem to be far enough under sellers' ideas to prevent extensive business. Producers report sales of *glaubers salt* in bags at 1½c. per lb. in carload lots. These interests are asking 1¾c. per lb. for smaller quantities. Spot oxalic acid is quoted from 18@19c. per lb. according to seller and quantity. It is somewhat possible to purchase a few odd lots at 17¾c. per lb. Producers quote the market at 17¾c. per lb. and upward f.o.b. works. The tone of the general market is steady with a fair number of inquiries reported in several quarters.

Coal-Tar Products

There is a growing disposition among the larger producers to maintain prices more firmly, not so much with the idea of holding the market at present prices, as to stabilize conditions and drive out all superfluous resale stock which threatened for a time to cause a serious depression in present prevailing prices. *Benzene* and *toluene* are firm, with an actual scarcity of benzene. England has been a consistent bidder for benzene for the past few months, but the fact that the facilities for loading tank steamers are controlled by the big oil firms together with curtailment of production due to the closing of many coke-ovens prevent shipments of material. One large factor reports that an average of several orders a week are being turnd down due to the above causes. Prices on benzene are firm at 27@33c. per gal., with very small supplies available. Inquiries are numerous, but sales are necessarily restricted. Imports of *cresylic acid* have been more sufficient to meet requirement and surplus stocks are available, but sellers are firm in their views of 68@75c. per gal. for the 97-99 per cent and 65@70c. on the 95 per cent. The English market is steady and present replacement costs allow little room for further price concessions. The demand for *cresol* is light and the market is barely firm at 16@18c. per lb. for the U. S. P. grade. The demand for *naphthalene* from the drug field has slackened and a consequent easing of the market is noted. Flakes are offered at 7c. per lb., balls at 8@10c. Most business is in resale goods. Producers of *toluene* quote 28@32c. per gal. Although the demand for this product has been quite strong recently, supplies remain limited.

The general inside quotation on *aniline oil* is 18c. per lb. with prices ranging up to 21c. on small lots. Sales of moderate quantities at the lower price is reported. Sellers of *benzaldehyde* show considerable variance in their price views with technical at 45c. per lb., U. S. P. material at $1.00@$1.25 per lb. and F. F. C. at $1.85 per lb. The demand remained dull. Producers of *benzyl chloride* report the market more active at lower prices, with the 95-97 per cent firm at 25@27c. per lb. and the technical at 20@23c. Small lot selling of *dimethylaniline* was done at 40c. per lb. and in some cases at 39c. The demand is light. Reduction on the base variety of *para-amidophenol* to $1.40 per lb. was made. The HCl was steady at $1.60@$1.75 per lb. Supplies are abundant and prices show the effect of surplus stocks. A decline to $1.60 per lb. was noted for *resorcinol* under keener competition. The demand is steady. Strong selling pressure in *beta-naphthol* is reducing prices. Supplies are more than sufficient to meet the current light demand. Prices range from 33@38c. per lb., with prospects of shading on actual business. In spite of foreign inquiries, the market on *para-nitroaniline* is easier and 75c. per lb. has been done on passing business. Current quotations range to 80c. per lb., but the lower figure is attracting all the business.

The St. Louis Market

St. Louis, Mo., July 21, 1921.

The drug and fine chemical market during the past two weeks has been rather quiet and featureless, nothing of importance having transpired recently. Inquiries are still numerous but not of large volume, and the consuming trade for the present moment are not disposed to take on more than for their immediate requirements. While the movement of heavy chemicals has also been slow the past two weeks, a number of inquiries on quite a few of the items gave the market a more optimistic tone, and it is to be hoped these inquiries are but the forerunner of a general activity on all heavy chemicals. Heavy importations of foreign chemicals continue to be noted and apparently importers are endeavoring to bring in as much of the foreign material as is possible before the new tariff becomes effective. The proposed tariff has not stimulated business to any noticeable extent.

Caustic soda remains quiet with a strict adherence to the manufacturer's schedule. The inquiry on *soda ash* has been very fair and while round lots are still quoted at $2.95 per 100 lb., sales have been reported at $2.60 per 100 lb. *Sal soda* and *sodium bicarbonate* remain inactive.

Carbon bisulphide continues to be one of the active items with a constant flow of inquiries resulting in quite a little business. *Hypo* continues to enjoy a routine demand. *Sulphur* holds its routine demand with price remaining at $2 per 100 lb., and less shading being reported.

Drugs and Pharmaceuticals

No change has occurred in the position of *ammonia water* 26 deg. and it continues to maintain its present schedule. Heavy importations of *bromides* are still being noted which have a very ill bearing on the domestic product and the situation at the present moment is not very promising. *Cream of tartar* is still in limited demand. *Epsom salts* is being quoted in carlots at $2.35@$2.50 per 100 lb., delivered, and less than carlots at $2.60@$2.75 per 100 lb., delivered. Factors have reduced their price on *ether* and a fair volume of business is being transacted. *Glycerine* is quoted at 14¾c. per lb., with a routine demand. The keen competition of secondhands on *iodides* seems to be gradually disappearing and giving ease to the situation. Manufacturers are hopeful that this commodity will again become firmer and on sounder basis. The *salicylates* are a seasonable article and a good volume of business is being enjoyed. A sudden and brisk demand has been experienced lately for *silver nitrate* and manufacturers are in position to meet this unexpected movement. At present *sodium benzoate* is moving slowly. However, it is anticipated that this condition should improve very shortly, in view of the approaching preserving and canning season. Quite a few inquiries for large quantities of *sulpho-carbolates* have been received the past week indicating that consumers' stocks are exhausted. A steady demand for *zinc stearate* still prevails. *Zinc oxides* remain firm since their last decline. The lead-free continues in fair demand by the rubber industry while the leaded zinc oxides remain in poor demand on account of the unusually dull period the paint trade is experiencing.

Acids

Heavy acids are more active than in the past with a fair increase in business. *Carbolic acid* remains at its present schedule with a fair demand. Although extremely warm weather has prevailed during the past few weeks over the entire country and no doubt considerable quantities of soft drinks have been consumed, there has been no indication of an increase for the demand of *citric acid* and the situation today does not give any better appearance than some few weeks past. There has been no improvement in the call for *tartaric acid* since the last reduction.

Vegetable Oils and Paint Materials

Linseed oil, after falling off a few cents, has risen sharply and holds firm at 81c. basis raw, in cooperage, ex warehouse. *Castor oil* still holds at 10½c. per lb. in drums with routine demand.

Lithopone continues to be the only pigment with a sustained demand. The price remains at 7½c. per lb., in carlots with a 25c. per 100 lb. freight allowance.

The Iron and Steel Market

PITTSBURGH, July 22, 1921.

The Steel market has undergone a sweeping change in character. The change has occurred quietly and realization that the market is on quite a new basis may not be universal. There is a silght increase in the total volume of demand upon the mills, and prices in general average a shade lower than a week ago.

The great change is that no mill now has a fixed price. There have been times when all mills had the same price, and other times when some mills had a certain price and other mills were cutting that price by an amount which each mill determined for itself. Now there is little difference between mills but much difference between quotations on different classes of orders. A mill may quote a certain price on a carload, then quote a materially lower price on 500 tons, and then quote the first price on a carload lot again. The desirability of the order is what counts. Mills are not counting upon profits, but are weighing the loss if an order is taken against the loss if the order is not taken. The cost of production including overhead exceeds any price now obtainable, but if a mill is entirely idle there is also a loss.

Another important change in the market is that "Pittsburgh plus" or the system of basing delivered prices all over the country on a basic price at Pittsburgh, rail freight from Pittsburgh to point of delivery being added, has disappeared in several commodities that are produced in large tonnages in different districts are likely to develop a separate market price for each district.

Market prices are therefore not clear cut, since different prices are obtainable on different sizes and degrees of attractiveness of orders. Quite an ordinary order could be placed at 1.90c. for plates, shapes or bars, while a larger order would probably draw the greatest concession in plates and the least in bars.

DEMAND INCREASED

The turn has been rounded in the matter of demand upon the mills, although it requires close scrutiny to discern the change. The long decrease is interrupted and it requires no enthusiastic temperament to predict that the lowest point in demand is entirely passed, since that lowest point represented a demand less than 20 per cent of the productive capacity.

A study of the bookings, in the form of new orders and of specifications against contracts shows that the demand is widespread as to classes of buyers and also geographically, also that the bulk of the demand is in small orders, with specifications decidedly mixed in character. There is evidently represented some further progress in the liquidation of stocks of steel in the hands of jobbers and manufacturing consumers and of stocks of finished wares in the hands of manufacturing consumers. There is no improvement in railroad buying and there is evidence that the general industrial activity of the country has increased. In other words, demand upon the mills for steel was below a natural relation to the general business activity of the country, and has now begun to trend towards the natural relation, which eventually may represent something like a 40 per cent operation of the steel industry. Operations since July 1 have hardly averaged 20 per cent.

CELERITY IN SHIPMENT A DECIDING FACTOR

Prices are not a vital factor in the steel business now being placed, celerity of shipment being the important matter. The buying is hand to mouth in character and the buyer wishes to realize on the material purchased within the smallest number of days possible after he has committed himself with the mill to take the material.

Pig iron continues to recede slowly, bessemer being quotable at $20.50, valley, basic at $19, valley and foundry at $19.50, valley, representing declines in the week of $1 in foundry and 50c. in bessemer and basic. Freight to Pittsburgh is $1.96, but some nearby furnaces would probably name lower prices delivered than the valley market plus the freight.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.12½ – $0.12½	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.75	3.00 – 3.25
Acetic, 56 per cent	100 lbs.	4.00 – 4.25	4.50 – 5.50
Acetic, glacial, 99½ per cent, carboys	100 lbs.	9.75 – 10.00	10.25 – 10.50
Boric, crystals	lb.	.13½ – .14	.14½ – .15
Boric, powder	lb.	.15 – .15½	.16 – .16½
Citric	lb.	..... –	.46 – .47
Hydrochloric	100 lb.	1.25 – 1.50	1.60 – 1.75
Hydrofluoric, 52 per cent	lb.	.12½ – .12½	.12½ – .13
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)	.....	..... –	..... – .....
Nitric, 40 deg	lb.	.06½ – .06½	.07 – .07½
Nitric, 42 deg	lb.	.07 – .07½	.07½ – .07½
Oxalic, crystals	lb.	.18 – .18½	.18½ – .19
Phosphoric, 50 per cent solution	lb.	.13½ – .14	.14 – .18
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.90 – 2.15
Sulphuric, 60 deg., tank cars	ton	..... –	11.75 – 14.00
Sulphuric, 60 deg., drums	ton	..... –	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 20.00	..... – .....
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 – 22.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P	lb.	..... –	.90 – 1.00
Tannic (tech.)	lb.	.45 – .48	.50 – .55
Tartaric, crystals	lb.	..... –	.29 – .30
Tungstic, per lb. of WO	lb.	..... –	1.30 – 1.40
Alcohol, Ethyl	gal.	..... –	4.80 – 5.00
Alcohol, Methyl (see methanol)	.....	..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.31 – .36
Alcohol, denatured, 190 proof	gal.	..... –	.38 – .42
Alum, ammonia lump	lb.	.03½ – .03½	.04 – .04½
Alum, potash lump	lb.	.03½ – .04	.04½ – .04½
Alum, chrome lump	lb.	.10 – .11	.11½ – .12½
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 – .07½	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.08 – .08½	.09 – .10
Ammonium chloride, granular (white salamoniac)	lb.	.06½ – .06½	.07 – .07½
Ammonium chloride, granular (gray salammoniac)	lb.	.06½ – .06½	.07 – .07½
Ammonium nitrate	lb.	.07 – .07½	.07½ – .08½
Ammonium sulphate	100 lb.	2.70 – 2.75	2.80 – 3.00
Amylacetate	gal.	..... –	4.00 – 4.25
Amylacetate tech	gal.	..... –	2.50 – 3.00
Arsenic oxide, (white arsenic) powdered	lb.	.06½ – .07	.07½ – .08
Arsenic, sulphide, powdered (red arsenic)	lb.	.11 – .11½	.12 – .13
Barium chloride	ton	59.00 – 59.50	60.00 – 62.00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.07½ – .07½	.08 – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .05½
Bleaching powder (see calc. hypochlorite)	.....	..... –	..... – .....
Blue vitriol (see copper sulphate)	.....	..... –	..... – .....
Borax (see sodium borate)	.....	..... –	..... – .....
Brimstone (see sulphur, roll)	.....	..... –	..... – .....
Bromine	lb.	.41 – .42	.43 – .45
Calcium acetate	100 lbs.	2.00 – 2.05	..... – .....
Calcium carbide	lb.	.04½ – .04½	.05 – .05½
Calcium chloride, fused, lump	ton	23.50 – 24.00	24.50 – 25.50
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2.15 – 2.25	2.35 – 2.50
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.75 – .78
Carbon bisulphide	lb.	.06½ – .07	.07½ – .08
Carbon tetrachloride, drums	lb.	.10½ – .10½	.11 – .12
Carbonyl chloride (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)	.....	..... –	..... – .....
Caustic soda (see sodium hydroxide)	.....	..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	..... –	.38 – .43
Cobalt oxide	lb.	..... –	3.00 – 3.10
Copperas (see iron sulphate)	.....	..... –	..... – .....
Copper carbonate, green precipitate	lb.	.19 – .19½	.20 – .21
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	lb.	.05½ – .06	.06½ – .06½
Cream of tartar (see potassium bitartrate)	.....	..... –	..... – .....
Epsom salt (see magnesium sulphate)	.....	..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	..... –	.85 – 1.00
Ethyl Acetate pure (acetic ether 98% to 100%)	lb.	..... –	.50 – .52
Formaldehyde, 40 per cent	lb.	.13 – .13½	.13½ – .14
Fusel oil, ref	gal.	..... –	3.00 – 3.25
Fusel oil, crude	gal.	..... –	1.75 – 2.00
Glauber's salt (see sodium sulphate)	.....	..... –	..... – .....
Glycerine, C. P. drums extra	lb.	..... –	.15 – .15½
Iodine, resublimed	lb.	..... –	3.65 – 3.75
Iron oxide, red	lb.	..... –	.10 – .20
Iron sulphate (copperas)	ton	19.00 – 20.00	21.00 – 22.00
Lead acetate	lb.	..... –	.11½ – .13½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.08½ – .08½	.08½ – .09
Lithium carbonate	lb.	..... –	1.30 – 1.40
Magnesium carbonate, technical	lb.	.09 – .09½	.10 – .11
Magnesium sulphate, U. S. P	100 lb.	2.40 – 2.75	..... – .....
Magnesium sulphate, technical	100 lb.	..... –	1.20 – 1.75
Methanol, 95%	gal.	..... –	.83 – .85
Methanol, 97%	gal.	..... –	.86 – .88
Nickel salt, double	lb.	..... –	.12 – .12½
Nickel salt, single	lb.	..... –	.14 – .14½
Phosgene (see carbonyl chloride)	.....	..... –	..... – .....
Phosphorus, red	lb.	45 – 46	47 – 50
Phosphorus, yellow	lb.	..... –	.35 – .37
Potassium bichromate	lb.	.11½ – .11½	.12 – .12½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .. – $....	$0.30 –$0.31
Potassium bromide, granular	lb.	..... –	.16 – .25
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, 80–85%	lb.	.05 – .05½	.06 – .07
Potassium chlorate, crystals	lb.	.07½– .07¾	.08 – .12
Potassium cyanide	lb.	..... –	.26 – .28
Potassium hydroxide (caustic potash)	lb.	.05 – .05½	.05½– .06
Potassium muriate, 80% K.C.l	ton	45.00 – 50.00	..... – .....
Potassium iodide	lb.	..... –	2.75 – 3.00
Potassium nitrate	lb.	.09½– .09½	.10 – .12½
Potassium permanganate	lb.	.29 – .30	.31 – .32
Potassium prussiate, red	lb.	.28 – .29	.29½– .30
Potassium prussiate, yellow	lb.	.22 – .22½	.23 – .23½
Potassium sulphate (powdered)	per unit	..... –	1.50 – 1.75
Rochelle salts (see sodium potas tartrate)		....	..... – .....
Salammoniac (see ammonium chloride)		....	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	20.00 –25.00
Silver cyanide	oz.	..... –	1.35 – 1.38
Silver nitrate	oz.	..... –	.40 – .41
Soda ash, light	100 lb.	2.05 – 2.10	2.15 – 2.45
Soda ash, dense	100 lb.	2.35 – 2.40	2.45 – 2.70
Sodium acetate	lb.	.04 – .04	.04 – .05
Sodium bicarbonate	100 lb.	2.25 – 2.40	2.50 – 2.75
Sodium bichromate	lb.	.08 – .08½	.08½– .09
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.05 – .05½	.05½– .06
Sodium borate (borax)	lb.	.06 – .06¼	.06½– .07
Sodium carbonate (sal soda)	100 lb.	1.90 – 2.00	2.10 – 2.40
Sodium chlorate	lb.	.07½– .07¾	.08 – .08½
Sodium cyanide	lb.	.19½– .21	.22 – .30
Sodium fluoride	lb.	.11½– .12	.12½– .13½
Sodium hydroxide (caustic soda)	100 lb.	3.90 – 4.00	4.10 – 4.50
Sodium hyposulphite	lb	..... –	.03½– .03¾
Sodium nitrate	100 lb.	2.50 –	2.60 – .....
Sodium nitrite	lb.	.07 – .07½	.07½– .08
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½– .04¾	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.26 – .27
Sodium prussiate, yellow	lb.	.11½– .12	.12½– .12¾
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.15	1.25 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02½– .03	.03¼– .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05 – .05½	.05½– .06½
Sodium sulphite, crystals	lb.	.03¾– .04	.04½– .04½
Strontium nitrate, powdered	lb.	.15 – .15½	.16 – .17
Sulphur chloride, red	lb.	.07 – .07½	.07½– .08
Sulphur, crude	ton	20.00 –22.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	..... – .....
Tin oxide	lb.	..... –	.40 – .42
Zinc carbonate, precipitate	lb.	.15½– .16	.16½– .17
Zinc chloride, gran.	lb.	.11 – .11½	.11½– .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.11½– .11½	.11¾– .12½
Zinc oxide, XX	lb.	.07½– .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.35 — .40
Aniline oil, drums extra	lb.	.18 — .21
Aniline salts	lb.	.25 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.25
Benzidine, base	lb.	.85 — 1.00
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .60
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.33 — .38
Beta-naphthylamine, sublimed	lb.	1.75 — 1.80
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.68 — .75
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.20 — 1.25
Dimethylaniline	lb.	.38 — .48
Dinitrobenzene	lb.	.26 — .28
Dinitroclorbenzene	lb.	.20 — .30
Dinitronaphthalene	lb.	.30 — .40
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.27 — .30
Dip oil, 25%, car lots, in drums	gal.	.40 — .45
Diphenylamine	lb.	.60 — .65
H-acid	lb.	1.15 — 1.25
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.75 — 1.85
Naphthalene crushed, in bbls.	lb.	.07 — .08½
Naphthalene, flake	lb.	.07 — .08½
Naphthalene, balls	lb.	.08½— .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.16 — .18
Ortho-amidophenol	lb.	3.10 — 3.20
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — .85
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.40 — 1.45
Para-amidophenol, HCl	lb.	1.60 — 1.75
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.75 — .80
Para-nitrotoluene	lb.	.85 — .95
Para-phenylenediamine	lb.	1.75 — 2.00
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.50 — .60
Phenol, U. S. P., drums	lb.	.09½— .11
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.60 — 1.65
Resorcinol, pure	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls.	lb.	.19 — .22
Salicylic acid, U. S. P.	lb.	.20 — .25
Salol	lb.	.80 — .85
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.25 — 1.35
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.25
Beeswax, refined, light	lb.	.27 — .28
Beeswax, white pure	lb.	.40 — .45
Carnauba, Flora	lb.	.58 — .60
Carnauba, No. 2, North Country	lb.	.25 — .26
Carnauba, No. 3, North Country	lb.	.13½— .14
Japan	lb.	.16 — .16½
Montan, crude	lb.	.06½— .06¾
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03 — .03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½— .....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½— .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½— .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½— .06
Stearic acid, single pressed	lb.	.09 — ....
Stearic acid, double pressed	lb.	.09½— ....
Stearic acid, triple pressed	lb.	.10 — .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.10 —	....
Rosin E-I	280 lb.	5.20 —	5.45
Rosin K-N	280 lb.	5.70 —	6.75
Rosin W. G.-W. W	280 lb.	7.35 —	.....
Wood rosin, bbl	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.59 —	.....
Wood turpentine, steam dist	gal.	.57 —	.....
Wood turpentine, dest. dist	gal.	.55 —	.....
Pine tar pitch, bbl	200 lb.	..... —	7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	11.50
Retort tar, bbl	500 lb.	—	11.50
Rosin oil, first run	gal.	.35 —	.....
Rosin oil, second run	gal.	.37 —	.....
Rosin oil, third run	gal.	.41 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.80
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.16 —	.17
Upriver coarse	lb.	.09 —	.09½
Upriver caucho ball	lb.	.11½ —	.12
Plantation—First latex crepe	lb.	.14 —	.....
Ribbed smoked sheets	lb.	.12 —	.12½
Brown crepe, thin, clean	lb.	.15 —	.....
Amber crepe No. 1	lb.	.17 —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.08½ —	$0.09
Castor oil, AA, in bbls	lb.	.10 —	.10½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.12 —	.12½
Cocoanut oil, Ceylon grade, in bbls	lb.	.10 —	.10½
Cocoanut oil, Cochin grade, in bbls	lb.	.10¾ —	.11
Corn oil, crude, in bbls	lb.	.08 —	.08½
Cottonseed oil, crude (f. o. b. mill)	lb.	.07½ —	.07½
Cottonseed oil, summer yellow	lb.	.09½ —	.09½
Cottonseed oil, winter yellow	lb.	.09½ —	....
Linseed oil, raw, car lots (domestic)	gal.	.77 —	.78
Linseed oil, raw, tank cars (domestic)	gal.	.71 —	.72
Linseed oil, 5-bbl lots (domestic)	gal.	.79 —	.80

Olive oil, Denatured	gal.	$1.30 —	$1.40
Palm, Lagos	lb.	.06½ —	.06¾
Palm, Niger	lb.	.05½ —	.05¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07 —	.07¼
Peanut oil, refined, in bbls	lb.	.10 —	.10¼
Rapeseed oil, refined in bbls	gal.	.90 —	.92
Rapeseed oil, blown, in bbls	gal.	.94 —	.95
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.06½ —	....
FISH			
Light pressed menhaden	gal.	$0.42 —	....
Yellow bleached menhaden	gal.	.44 —	....
White bleached menhaden	gal.	.46 —	....
Blown menhaden	gal.	.50 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	7.00 —	....
Blanc fixe, dry	lb.	.04¾ —	.04½
Blanc fixe, pulp	net ton	45.00 —	55.00
Casein	lb.	.06½ —	.07½
Chalk, domestic, extra light	lb.	.04½ —	.05
Chalk, domestic, light	lb.	.04 —	.04½
Chalk, domestic, heavy	lb.	.03½ —	.04
Chalk, English, extra light	lb.	.04½ —	.05
Chalk, English, light	lb.	.04½ —	.05
Chalk, English, dense	lb.	.04 —	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	25.00
China clay (kaolin), imported, lump	net ton	12.00 —	20.00
China clay (kaolin), imported, powdered	net ton	20.00 —	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Pa	net ton	15.00 —	18.00
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.07½ —	.08
Graphite, Ceylon chip	lb.	.06 —	.06½
Graphite, high grade amorphous crude	lb.	.02¾ —	.03
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.58 —	.60
Shellac, orange superfine	lb.	.73 —	.74
Shellac, A. C. garnet	lb.	.46 —	.47
Shellac, T. N	lb.	.47 —	.48
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	12.50 —	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00 —	14.00
Talc, imported	ton	30.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	$37.50–40.00	
Carborundum refractory brick, 9-in.	less than carlot	1.000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	60	..
Chrome cement, 40–45% Cr_2O_3	net ton	30–	32
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	33–	35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	36–	40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30–	35
Magnesite brick, 9-in. straight	net ton		70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	42–	45
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	46–	50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	35–	38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.14 —	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.15 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	70.00 —	....
Ferromanganese, 76-80% Mn, English	gross ton	70.00 —	....
Spiegeleisen, 18-22% Mn	gross ton	27.00 —	28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50 —	....
Ferrosilicon, 10-15%	gross ton	40.00 —	42.00
Ferrosilicon, 50%	gross ton	65.00 —	68.00
Ferrosilicon, 75%	gross ton	135.00 —	138.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.50 —	5.00

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.30 —	.33
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	30 —	.33
Coke, foundry, f.o.b. ovens	net ton	4.00 —	4.50
Coke, furnace, f.o.b. ovens	net ton	2.75 —	3.00
Coke, petroleum, refinery, Atlantic seaboard	net ton	14.00 —	15.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	12.50 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	.....
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.21 —	.....
Manganese ore, chemical (MnO_2)	gross ton	50.00 —	55.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.14 —	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.14 —	.14
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.12 —	.13
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75 —	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	.....
Zircon, washed, iron free	lb.	.03 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.25@12.50
Aluminum, 98 to 99 per cent	24.5@25
Antimony, wholesale lots, Chinese and Japanese	4½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	26.50
Lead, New York, spot	4.35–4.40
Lead, E. St. Louis, spot	4.20–4.25
Zinc, spot, New York	4.50–4.55
Zinc, spot, E. St. Louis	4.15–4.20

OTHER METALS

Silver (commercial)	oz.	$0.59½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	72.00@75.00
Iridium	oz.	160.00@180.00
Palladium	oz.	60.00–65.00
Mercury	75 lb.	44.00–45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.75–21.25
Copper bottoms	28.25–28.75
Copper rods	19.75–20.00
High brass wire	16.75
High brass rods	13.75
Low brass wire	18.25
Low brass rods	18.25
Brazed brass tubing	27.00
Brazed bronze tubing	31.75
Seamless copper tubing	21.00
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.25@ 9.50	9.25	9.50
Copper, heavy and wire	8.25@ 8.50	8.50	8.50
Copper, light and bottoms	7.25@ 7.75	7.50	7.25
Lead, heavy	3.25@ 3.50	3.25	3.25
Lead, tea	2.25@ 2.35	2.25	2.25
Brass, heavy	4.25@ 4.50	4.50	5.00
Brass, light	3.25@ 3.50	3.25	3.50
No. 1 yellow brass turnings	4.25@ 4.50	4.25	4.50
Zinc	2.00@ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. aref or structural shapes 3 in. by ¼ in. and arger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.23	$3.00	$3.00
Soft steel bars	2.18	2.80	2.80
Soft steel bar shapes	2.18	2.90	2.90
Soft steel bands	2.50	3.20	3.20
Plates, ¼ to 1 in. thick	2.18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Stringer Brothers Foundry Co., 109 North Dearborn St., Chicago, Ill., manufacturer of brass and iron goods, has commenced the construction of a new plant at Gadsden, to be operated as a branch works. An extensive iron and brass foundry will be installed. It is planned to inaugurate operations at an early date. Charles C. Stringer is president.

GADSDEN—The Gadsden Clay Products Co., recently organized, will operate a local plant for the manufacture of building tile and other burned clay products. The initial works will be enlarged at a later date and new machinery installed. Robert Riley is president and Gordon Hood, treasurer.

California

OAKLAND—The Moore Shipbuilding Co., foot of Adeline St., has filed plans for the erection of a new 1-story brass foundry at its plant.

Delaware

WILMINGTON—The Atlas Powder Co., du Pont Bldg., is taking bids for the construction of a new 1-story experimental laboratory at Gray St., and Lancaster Ave., 60x80 ft.

District of Columbia

WASHINGTON—A. L. Flint, general purchasing officer, the Panama Canal, will receive bids until 10:30 a.m., August 3, for chemicals, lime, creosote oil, calcium chloride, varnish, linseed oil, and other materials and equipment, as set forth in Circular 1453, for Canal Zone service.

Florida

TAMPA—The United Paper Co., Atlanta, Ga., has awarded a contract to E. W. Parker, Curry Building, Tampa, for the erection of a new local plant, 100x100 ft., for the manufacture of paper specialties. It is estimated to cost about $50,000, including machinery. N. Sargent Hamilton, Atlanta, is architect. Louis Wellhouse is president.

MADISON—The Producers' Co., manufacturer of peanut oil and kindred products, has resumed production at its local plant after a curtailment of several months duration. The company is giving employment to about 75 operatives, and plans to increase this force to 100 persons. It is proposed to operate under full time for an indefinite period.

Illinois

CHICAGO—Curt, Teich & Company, 1745 Irving Park Boulevard, manufacturer of paper specialties, has awarded a contract to Peter Hamel, 6401 South Campbell St., for the erection of a 2-story plant addition, 125x125 ft., estimated to cost about $100,000 with machinery. Ground will be broken at an early date.

CHICAGO—The Wheeling Corrugating Co., 2547 Arthington Ave., is taking bids for the erection of a new 1-story plant addition, 80x125 ft., estimated to cost about $40,000.

Indiana

MICHIGAN CITY—The Triangle Steel Products Co., care of T. C. Casse, 163 Washington St., has plans under way for the erection of a new 1-story and basement plant at Michigan City, 250x500 ft., estimated to cost about $75,000 with machinery.

Louisiana

NEW ORLEANS—Fire, July 6, destroyed a portion of the Richardson chemistry building at the Tulane University, with loss estimated at about $17,000. The structure will be rebuilt.

COLEMAN—D. C. Nelson, Fort Worth, Tex., and associates, are organizing a new company to build and operate a local oil refining plant. Details and estimates of cost are being made.

NEW ORLEANS—The Marland Refining Co., Ponca City, Okla., has acquired property at St. Charles Parish, about 20 miles from New Orleans, and has plans under way for the erection of a new oil terminal plant to cost in excess of $1,000,000, including equipment.

CARGAS—The United Oil & Natural Gas Products Co., Monroe, La., is planning for the erection of a new local plant for the manufacture of gasoline to cost about $30,000.

Maryland

BALTIMORE—Fire, July 9, destroyed the plant of the Meadowbrook Dye Works, Caton Ave., with loss estimated at about $30,000. It is said that the plant will be rebuilt.

Mississippi

MERIDAN—The Texas Oil Co. and the Gulf Refining Co. are planning for the rebuilding of the portions of their local oil plants, destroyed by fire, June 28, with loss estimated in excess of $100,000, including equipment.

Missouri

KANSAS CITY—The Central Chemical & Supply Co., has leased a local building, 3-story, totaling about 20,000 sq.ft. of space, for the establishment of a new works for the manufacture of paints and kindred products. Machinery will be installed at an early date. C. H. Hughes is head.

CLINTON—The Terrill Tire & Rubber Co., 1512 McGee St., Kansas City, Mo., has awarded a contract to Frank Woodruff, Clinton, for the erection of its proposed new local plant, to be 2-story and basement, 90x150 ft., and estimated to cost about $32,000. A. C. Terrill is president.

ST. LOUIS—The Fleischmann Yeast Co., 1535 Market St., has filed plans for the erection of its proposed local plant on Forest Park Boulevard, 1-story, 75x170 ft., estimated to cost about $50,000. H. K. Stephens is local manager.

New Jersey

NEWARK—The United Butchers' Fat Rendering Co., Robert H. Bayerl, 302 Jackson Ave., Jersey City, N. J., president, is having plans prepared by David M. Ach, 1 Madison Ave., New York, architect, for its proposed new rendering plant on Doremus Ave., Newark, for fertilizer, glue, tallow and affiliated manufacture. It will be 2-story and is estimated to cost about $50,000. Bids will be taken at an early date.

FLORENCE—The Florence Pipe Foundry & Machine Co., has awarded a contract to the Austin Co., Bulletin Bldg., Philadelphia, Pa., for the erection of a new 1-story building at its plant, 40x100 ft., estimated to cost about $25,000. C. L. Reeves is head.

New York

BUFFALO—Fire, July 10, destroyed a portion of the plant of the Archer-Daniels Linseed Co., Hamburg Turnpike, with loss estimated at about $50,000, including equipment.

BUFFALO—The Towns Paint Co., Inc., has established a new plant at 127 Erie St. and has arranged for immediate manufacture, with production to include paints, varnishes, etc. Joseph C. Alonzo, formerly chief chemist and assistant superintendent of the Campbell Paint & Varnish Co., St. Louis, Mo., will be in charge of operations.

NIAGARA FALLS—The Sinclair Consolidated Oil Corp., 120 Broadway, New York, is reported to have purchased a local site, comprising a large acreage, for the erection of a new oil refining plant, estimated to cost in excess of $2,500,000 with machinery.

NEW YORK—The Tide Water Oil Co., 11 Broadway, has taken over the property of the Guffey-Gillespie Oil Co., including refineries and oil plants, and will operate the business in the future. The name of the company will be changed to the Tidal Osage Co.

LONG ISLAND CITY—The Textile Alliance, New York, has leased for a long term, the factory building now being erected on a site 95x100 ft., on Van Alst Avenue, near Harris Ave., Long Island City, for dye operations, including departments for production, rehandling, reconditioning, etc.

North Carolina

RUTHERFORDTON—The Sylvania Gold Mining Co., recently incorporated with a capital of $250,000, is planning for the development of gold properties in this section, recently acquired. The tract totals about 225 acres, and will be provided with a complete mining and operating plant. Lee A. Warrick, is president and general manager.

Ohio

CORTLAND—The Quinley Magnesia Co., 306 Federal Bldg., Youngstown, Ohio, has completed foundation work for a new plant at Cortland, to be 3-story, 40x80 ft., and will commence the erection of superstructure at an early date. J. C. Quinley is president and mechanical engineer for the work.

CLEVELAND—The Sterling Brass Co., 4610-12 St. Clair Ave., has rejected bids recently received for the erection of its proposed new brass foundry at St. Catherine and East 93 Streets. Revised plans will be drawn and new bids asked. The plant, with machine shop, will be 2-story, 145x200 ft., and is estimated to cost about $100,000. S. L. Weil is head.

Pennsylvania

CHESTER—The American Chemical & Sugar Machinery Co., Colonial Trust Building, Philadelphia, Pa., has acquired the local plant of the Harrison Chemical Co., and will commence the erection of superings for a new plant. Machinery will be installed at an early date. It is proposed to give employment to about 200 operatives. The plant has been shut-down for some time past, and at time of erection was used as a foundry.

PHILADELPHIA — Samuel McDowell, manufacturer of chemicals, has acquired a local plant, formerly occupied by the Providence Worsted Mills, for a new factory. Equipment will be installed at once, and the works operated as a branch of the present chemical plant.

South Carolina

ORANGEBURG—The Common Council is considering the erection of a new municipal gas plant, estimated to cost about $100,000. Edward Hawes, engineer, City Bldg., is preparing preliminary plans.

Texas

WACO—W. A. Rogers, Houston, Tex., and associates, have acquired the local oil refinery of the Ryan & Fisher Refinery & Production Co. Plans are under way to increase the capacity of the plant from 500 to 1,000 bbl. a day.

CISCO—The Cisco Clay & Coal Co. is considering the erection of a new local plant for the manufacture of brick and tile. At a later date an extension will be constructed to be devoted to the manufacture of paving brick and other burned clay products. C. B. Bush is president.

Utah

SALT LAKE CITY—Fire July 5 destroyed a portion of the plant of Acme White Lead & Color Works, 255 Edison St. Plans for rebuilding are said to be under way.

West Virginia

HUNTINGTON—The Melick Petroleum & Coal Co., recently organized with a capital of $5,000,000, is planning for the erection of a new oil-refining plant to cost close to $1,000,000 with equipment. David L. Melick is president and general manager.

Wisconsin

NEENAH — The Valley Paper Mills, 5 Caswell Block, are having plans prepared by Edward A. Wettengal, 578 Pierce Ave., Appleton, Wis., for the erection of their proposed new local paper manufacturing plant, estimated to cost close to $500,000 with machinery. A. C. Ehlmann is president.

Quebec

KIPPEWA—The Riordan Paper Co. is planning for the rebuilding of the portion of its local mill, destroyed by fire, June 22, with loss reported at about $25,000.

New Companies

THE PUBLIC OIL CO., Room 720, 10 South LaSalle St., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are Paul Vitek and George Kucharik.

THE PINNACLE PAINT CO., Sault Ste. Marie, Mich., has been incorporated with a capital of $15,000, to manufacture paints, oils, varnishes, etc. The incorporators are Pearson S. Conrad Jr., Campbell E. Lyons and Walter H. McKinney, Sault Ste. Marie.

THE KEMOSHYNE PRODUCTS, INC., Camden, N. J., has been incorporated with a capital of 4,000 shares of stock, no par value, to manufacture polishes, oils and kindred products. The incorporators are Thomas B. Kenworthy, M. G. Black and Delbert S. Bacon. The company is represented by Walter R. Carroll, Fourth and Market Streets, Cadmen.

THE PLYMOUTH CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture chemical and chemical by-products. The incorporators are E. Stark, F. F. Jones and M. Rothman. The company is represented by J. D. Campbell, 200 Fifth Ave.

THE COMMERCIAL TALC CO., Lincoln, R. I., has been incorporated with a capital of $300,000, to operate talc properties and talc refining plants. The incorporators are George R. Price, John P. Sheern and George Messinger, 650 Broad St., Providence, R. I.

THE MOUNTAIN CITY CHEMICAL CO., Fairmont, W. Va., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical by-products. The incorporators are Brooks S. Hutchison and J. V. Abbott, Fairmont.

THE ALLAN MFG. CO., St. Paul, Minn., has been incorporated with a capital of $50,000, to manufacture soaps and kindred products. The incorporators are E. M. Hagan, H. K. Null and George W. Allan, St. Paul.

C. H. FINGERHOOD, INC., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture industrial alcohol and affiliated products. The incorporators are E. Nelson, F. and C. H. Fingerhood, 911 Southern Boulevard.

THE SAMOSET OIL CO., Boston, Mass., has been incorporated with a capital of $300,000, to manufacture refined oil products. Charles M. Bergui is president, and Michael A. Dunn, 11 High St., Framingham, Mass., treasurer.

THE EASTERN PETROLEUM CORP., New York, N. Y., has been incorporated with a capital of $180,000, to manufacture petroleum products. The incorporators are G. A. Ross, F. C. Sumner and J. W. Seemens. The company is represented by J. R. Meany, 205 West 91st. St.

THE PARKO MFG. CO., Rochester, N. Y., has been incorporated with a capital of $250,000, to manufacture soaps, polishing compounds, etc. The incorporators are J. G. Rispor, L. C. Graves and C. F. Wray. The company is represented by Stull Bros., attorneys, Rochester.

THE BRONSON CHEMICAL CO., 234½ Broad St., Providence, R. I., has filed notice of organization to manufacture chemical products. The company is headed by Moody D. Holmes.

THE CENTRAL OIL & GREASE CO., INC., Williamsport, Pa., has been incorporated with a capital of $50,000, to manufacture oils, greases, compounds, etc. Frank W. Kosh, South Williamsport, Pa., is treasurer.

THE PYRO COLOR CORP., Richmond, Va., has been incorporated with a capital of $1,250,000, to manufacture colors, chemicals, dyes, etc. The incorporators are Lee B. Horey and W. C. Faulkner, Richmond.

THE KENTUCKY MIDLAND PIPE LINE AND REFINING CO., New York, N. Y., has been incorporated under Delaware laws with a capital of $5,000,000, to manufacture refined oil products. The company is represented by Arthur W. Britton, 65 Cedar St.

THE HARRISVILLE ORE & STEEL CORP., New York, N. Y., has been incorporated with a capital of $500,000, to operate iron ore properties, and manufacture steel and other metal products. The incorporators are H. G. Conway, E. G. Kerr and M. F. Dudek. The company is represented by Peaslee & Compton, 501 Fifth Ave.

THE ORANGEVILLE BRICK & SHALE PRODUCTS CO., Orangeville, Ohio, has been incorporated under Pennsylvania laws with a capital of $100,000, to manufacture brick and other burned clay products. E. W. Hyde, Orangeville, is treasurer.

THE MODERN CHEMICAL CO., Chelsea, Mass., has been incorporated with a capital of $10,000, to manufacture chemicals, and chemical byproducts. Samuel Leabman is president, and David Glassman, 99 Shurtleff St., Chelsea, is treasurer.

THE WEBACO OIL CO., Webster (Monroe Co.), N. Y., has been incorporated with a capital of $100,000, to manufacture refined oil products. The incorporators are G. B. and E. Kittelberger, and C. E. Sutter, Webster.

THE FLORIMER CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are M. Levin, P. J. Rassler and T. T. Schwalbe. The company is represented by A. J. Halprim, 41 Park Row.

THE CONVERSE TIRE CO., Malden, Mass., has been incorporated with a capital of $1,000,000, to manufacture automobile tires and mechanical rubber goods. Marquise M. Converse is president; Hugh Bullock, 392 Pearl St., Malden is treasurer.

THE DUNCAN LUBRICANT OIL WORKS, INC., Duncan, Okla., has been incorporated with a capital of $50,000, to manufacture lubricating oils, compounds, etc. The incorporators are J. R. Frensley, and Roy K. Wilson, Duncan.

THE MISSOURI VALLEY OIL CO., Sioux City, Ia., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are M. P. Summers, C. E. Naughton and C. T. Mauller, Sious City.

THE ARGONNE CHEMICAL AND DRUG CO., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture chemicals, chemical byproducts, drug compounds, etc. The incorporators are J. and P. Dondero and C. McLester. The company is represented by Ryan, Heffernan & Dowan, 25 West 45 St.

THE STANDARD CHEMICAL CORP., 723 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of $300,000, to manufacture chemical specialties. The incorporators are Luther E. Mellen, Jacob L. Rosenfield and J. Charles Fagan.

THE PENN RUBBER PRODUCTS CORP., Philadelphia, Pa., has been incorporated with a capital of $500,000, to manufacture rubber specialties. The company is represented by F. R. Hansell, Land Title Bldg.

MASON & URNER, INC., Newark, N. J., has been incorporated with a capital of $125,000, to manufacture refined oil products. The incorporators are Thomas T. Gray, Frank A. Urner and Frank B. Mason, 961 Frelinghuysen Ave.

THE SAMOLINE CORP., Room 2134, 6 North Clark St., Chicago, Ill., has been incorporated with a capital of $350,000, to manufacture paints, oils, varnishes and kindred products. The incorporators are Samuel R. Olmsted, Martin Skarie and Thomas A. Weldon.

THE LIBERTY PETROLEUM CORP., 1119 Fidelity Building, Baltimore, Md., has been incorporated with a capital of $2,500,000, to manufacture petroleum products and hydrocarbons. The incorporators are Edward M. and E. H. Hammond and Harry E. Karr.

THE LA PREME IVORY NOVELTY CO., Bloomfield, N. J., has been incorporated with a capital of $25,000, to manufacture celluloid and other composition products. The incorporators are Richard Webster and G. A. Breite, Passaic Ave. and Center St.

THE CORTLAND DRUG & CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, drug compounds, etc. The incorporators are R. Cairone, W. S. Berman and H. Herzog. The company is represented by C. Firestone, 299 Broadway.

THE NITRO FOUNDRY CO., Nitro, W. Va., has been incorporated with a capital of $50,000, to manufacture iron, steel and other metal castings. The incorporators are Ralph Matthews, M. S. Aldrich and W. A. O'Neill.

THE PROCESS PAPER CO., Lockport, N. Y., has been incorporated with a capital of $50,000, to manufactrue paper products. The incorporators are G. E. Greene, G. F. McEndoe and G. C. Lewis, Lockport.

THE NOVO LABORATORIES, INC., Perth Amboy, N. J., has been incorporated with a capital of $125,000, to manufacture chemicals and chemical byproducts. The incorporators are Samuel Cutler, M. A. Fenwick and Boris I. Rabiner, 651 Catherine Street, Perth Amboy.

THE LINCOLN CONNER CORP., New York, N. Y., has been incorporated with a capital of $60,000, to manufacture inks, dyes, chemicals and affiliated products. The incorporators are D. Greenebaum and L. and B. F. Conner. The company is represented by S. Wasserman, 51 Chambers Street.

THE WESTFIELD CHEMICAL CORP., New York City, has been incorporated with a capital of $25,000 to manufacture chemicals and affiliated products. The incorporators are G. Giofre, C. Cacetta and F. A. Brune, 395 B'way.

THE PURITY CHEMICAL PRODUCTS CO., Jeffersonville, Ind., has been incorporated with a capital of $5,000 to manufacture chemicals and chemical byproducts. The incorporators are J. B. Doherty, G. H. Haas and D. C. Peyton, Jeffersonville.

Capital Increases, etc.

THE WISCONSIN LIME & CEMENT CO., 133 West Washington St., Chicago, Ill., manufacturer of cement, lime products, etc., has filed notice of increase in capital from $200,000, to $1,000,000.

THE RICH STEEL PRODUCTS CO., Battle Creek, Mich., is arranging for a decrease in its capital from $250,000 to $100,000.

THE SUPERIOR FLUOR SPAR CO., Evansville, Ind., has filed notice of dissolution under state laws.

L. MUNDET & SON, INC., Ferris St., Brooklyn, N. Y., manufacturer of cork products, has filed notice of increase in capital from $350,000 to $2,500,000.

THE CUMBERLAND HYDRAULIC CEMENT & MFG. CO., Cumberland, Md., has filed notice of increase in capital from $200,000 to $450,000.

THE COLE CHEMICAL CO., 406 Market St., St. Louis, Mo., has filed notice of increase in capital from $50,000 to $1,000,000.

THE DETROIT COPPER & BRASS ROLLING MILLS INC., North Jefferson Street, Chicago, Ill., has filed notice of dissolution under state laws.

THE ELGIN RUBBER ACE CO., Elgin, Ill., has filed notice of increase in capital from $150,000 to $500,000.

THE KINZIE RUBBER & MFG. CO., 1514 West Kinzie St., Chicago, Ill., has filed notice of increase in capital from $350,000 to $412,500.

THE PACIFIC-TEXAS PETROLEUM CO., Mineral Springs, Tex., has filed notice of increase in capital from $1,000,000 to $4,000,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY'S summer meeting is being held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters are at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.